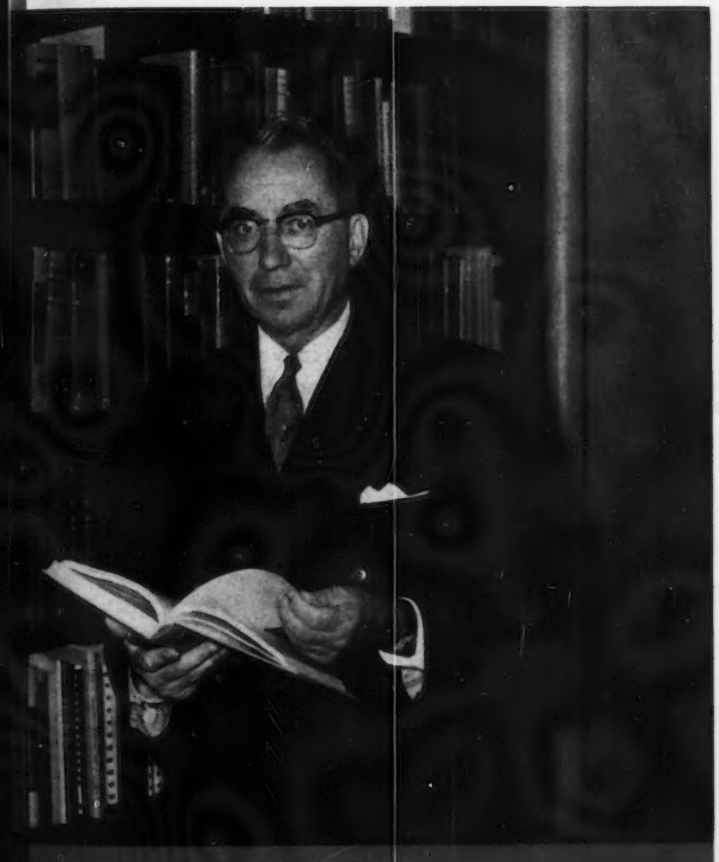
CEREAL SCIENCE today

FEBRUARY 1961 • VOL. 6 • NO. 2 • 35c COPY



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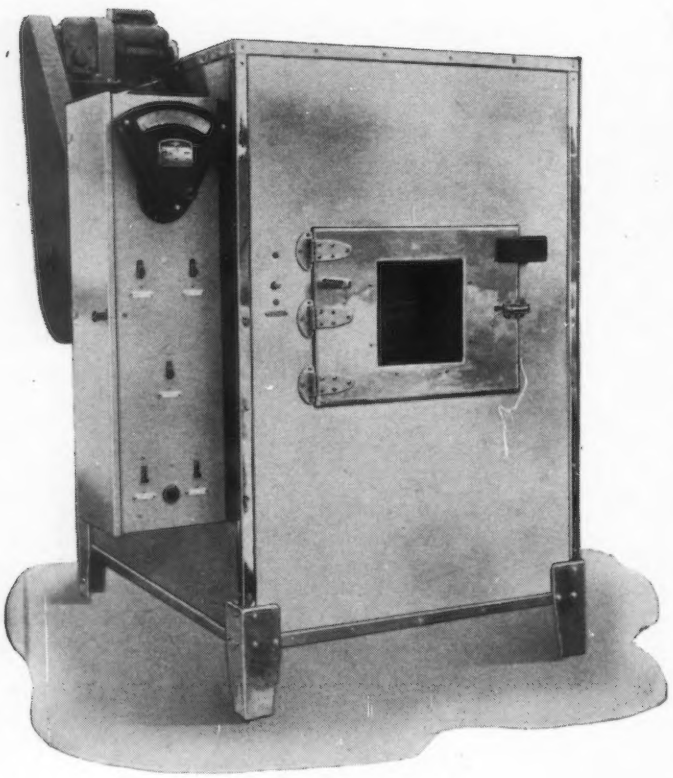

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PURPOSE

The American Association of Cereal Chemists is devoted to: 1) the encouragement of scientific and technical research on cereal grains and their products; 2) the study of development and standardization of analytical methods used in cereal chemistry; 3) the promotion of the spirit of scientific cooperation among all workers in the field of cereal chemistry; 4) the maintenance of high professional standards of its membership; and 5) the encouragement of a general recognition of the value of the chemist and biologist to the cereal industries.

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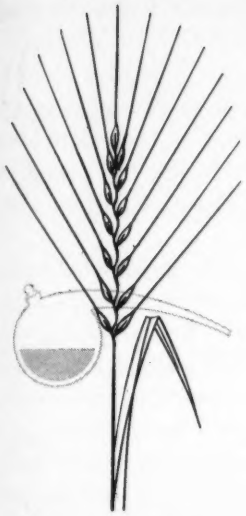
Membership in the AACC is open to professionally qualified individuals anywhere in the world. Corporate memberships are available for those companies wishing to lend industry support to the scientific work of the Association. An application form for membership may be obtained by writing the American Association of Cereal Chemists, 1955 University Avenue, St. Paul 4, Minnesota.



FEATURES

COVER: "Bill" Geddes in his office.

CEREAL SCIENCE today

FEBRUARY 1961 VOLUME 6 NUMBER 2

DEPARTMENTS

CEREAL SCIENCE Today is published ten times per year (monthly except June and August) by the American Association of Cereal Chemists, from 500 South 5th Street, Minneapolis 15, Minnesota. Editorial, Circulation and Advertising Headquarters: 1955 University Avenue, St. Paul 4, Minnesota. Second class postage paid at Minneapolis, Minnesota.

The American Association of Cereal Chemists assumes no responsibility for the statements and opinions advanced by contributors to its publications. Views expressed in the editorials are those of the editors and do not necessarily represent the official position of the American Association of Cereal Chemists.

Subscription rates: 1 year, $3.00; 2 years, $5.00; 3 years, $7.00. Foreign postage: $1.00 per year extra. Back issues available on request. Single copies: 35 cents.

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editorial

WILLIAM FINDLAY GEDDES died of a heart attack January 7, 1961, in Mexico City, where he and his wife had gone that he might get some relief from the respiratory illnesses that tormented him.

Editor of *Cereal Chemistry* for seventeen years, editor of *Cereal Science Today* at its inception, leader and member of the AACC for many years, professor, lecturer, writer, Osborne Medalist, and recipient of many other awards and honors, he was known and welcomed in scientific circles throughout the nation and the world. His stature as a scientist reflected to the good of the Association both within and from without the organization.

But the story is larger and much more important to all of us. There is no single member of the AACC who hasn't been touched, directly or indirectly, by the influence of Dr. Geddes. Most of us knew him — his quick handshake, his cordiality, his interest. We knew and were grateful for his concern that the presentation of work measure up to its worth and for his patience in helping to accomplish that end, as we are grateful for the high standards of work and research that he set. His professional thoroughness, honesty, and exactness were always heightened by his sense of fun, his good humor, and his love of discussion. His real desire to acknowledge and give every credit for the work and help of others was a part of his own genuine modesty. He valued time exceedingly, but he was spendthrift with his own because there were so many of us who asked for it so often. He gave it gladly and generously — to the Association as a whole, to us as individuals.

To many of us, he has been a longtime friend or teacher or associate or advisor. To some of us, he has been all these things. In each capacity, he has given the same devotion and interest he gave to all of life, warmly, spontaneously, and unstintingly. He is an irreplaceable figure in our personal and professional lives.

Each of us in his own heart feels deeply the loss of such a man, but we feel even more the sense of great privilege in having known him. And, to each of us, he has given and left with us a share of himself.

P. E. R.

EDITOR'S NOTE: At the Tristate regional meeting of AACC Local Sections in Manhattan, Kansas, October 7 and 8, a symposium on particle size analysis was presented. It is our pleasure to present the major papers given, along with Mr. Avrom Handleman's report for the AACC Particle Size Committee and Mr. Crowley's introductory remarks, following, as Chairman of the Committee.

Introduction to the AACC's Symposium on

Particle Size

By P. R. Crowley
Chairman, Committee on Particle Size, AACC, General Mills, Inc., Minneapolis, Minn.

On October 7 and 8 the Particle Size Committee presented a symposium at the Tristate regional meeting at Kansas State University, Manhattan, Kansas. In addition to papers on particle size measurements and applications (appearing in this issue of Cereal Science Today), reports were given on the activities and progress of the Particle Size Committee. These reports covered the two general divisions of size analysis being considered by the Committee, sieve and subsieve.

The long-range objective of the Particle Size Committee is to recommend a method or methods of size analysis which will allow universal recognition of the size distributions of powdered and granular materials used by cereal chemists. Because of the large range of sizes of these materials and their variations in behavior, the Committee has facilitated its work, first by dividing the field into the two areas, sieve and subsieve analysis, and second, by confining its work temporarily to the analysis of wheat flour.

The two areas, sieve and subsieve analysis, have been differentiated on the basis of size using 100μ as the divisional criterion but recognizing that some overlap exists. The following reports summarize the information presented at Manhattan in these two areas of activity.

Subsieve Analysis

The current emphasis in cereal technology on research and development and the increasing use of analytical techniques to provide a basis for process control has demanded the use and standardization of several additional analytical tools by cereal chemists. Particle size analysis is one of these tools.

Subsieve particle size analysis is not a new technique. It has been employed for years in many industries dealing with small particles. In fact, a number of cereal processing organizations have been and are using subsieve size analysis routinely. But because of the large number of specific methods which have been developed for subsieve size analysis, and the variations in requirements of the cereal industry, no universal agreement has been reached on a standard method.

During the summer of 1960, the Size Analysis Committee circulated a questionnaire among organizations known to be working with size analysis of wheat flour, in which they were asked to give their requirements for a method of size analysis. The questions and the results of this survey are listed in Table I. Assuming that these results are representative, it may be concluded that the requirements of the wheat flour industry are quite varied and the possibility exists that no single technique will satisfy all of the industry.

To establish to what extent the current methods of analysis approach satisfying these requirements, a series of samples was sent to members of the Committee and several interested collaborators for size analysis. The methods of analysis included in this study were:

Whitby Centrifuge (Mine Safety Appliance)
Coulter Counter
Andreasen Pipet
Micromerograph (Sharples)
Sedimentometer (Simon)
Evans Sedimentation
Gallenkamp Sedimentation
Micromesh Sieves

The results of these analyses, together with information as to equipment cost, operating time, etc., will be used to characterize each of the methods.

The intention of the Particle Size Committee is to examine the characteristics of these methods in the light of requirements established through the questionnaire and recommend one method to be published in *Cereal Laboratory Methods* as the official AACC method. It is also the Committee's intention to publish the characteristics of the other methods in order that cereal chemists can be aware of their features and, if they so desire, select for use the one which comes closest to meeting the requirements of their specific applications.

As time permits, the Committee intends to examine size analysis methods as applied to materials other than wheat flour and recommend additional procedures for inclusion in *Cereal Laboratory Methods*.

A Review of Principles and Problems in

Sieve Analysis of Cereal Products

Comprising the Report of the AACC Particle Size Committee

By Avrom R. Handleman
Inorganic Research Laboratory, Monsanto Chemical Co., St. Louis, Mo.

When sieving results are to be used to describe all or part of a size distribution, certain precautions are required for this distribution to be meaningful. These precautions include (a) adherence to a procedure in which sieving method and time, sieve cleaning, and sample size for the particular screen-material combination are specified, and (b) the use of sieves which are known to conform to exact performance specifications.

A consideration of sieving mechanics demonstrates the need for specifying sieving time and method. At the beginning of the sieving process, all particles which are much smaller than the sieve openings pass through relatively quickly. Then, as sieving proceeds, larger and larger material passes through, eventually including particles capable of passing in certain directions only. The amount passed in a given time becomes smaller and smaller, but all the material capable of passing the openings will not pass in practical time limits. This is illustrated in Fig. 1, a plot of percent retained vs. sieving time for whole-wheat flour on a 140-mesh screen. In the first minute a great deal of material passes, and the additional amount passed per minute becomes less and less. However, as sieving is continued, measurable amounts of material continue to pass even after 8 minutes (the duration of most of our single sieve tests). Even so, the amount passed in a specified sieving time is quite reproducible when other factors are controlled; hence this measure can satisfactorily indicate the size fraction.

The ideal sample size is the minimum which is still representative, since the larger the sample the longer the sieving time required for the same equivalent separation. Since the number of particles per unit weight of material is less in coarse sizes, sample size must be increased as screen size is increased for representative results. These relationships reduce the reliability of size distributions obtained from stacked sieve measurements, since sieving time/sample-size relationships cannot be ideal for all sizes with a single sample. Thus, if the sample size is adequate for the larger screen sizes, and a considerable amount of the material passes them, it will be too large for good separation of the fines. On the other hand, if the sample is of proper size for measurement of the fines, it will not be representative for the coarse fractions. One solution proposed by the committee is to stack sieves with nesting catch pans between, and weigh a suitable amount of sample on each sieve. All committee work to date has been with single sieves because of this problem.

With these problems in mind, the committee undertook a program of collaborative analyses in the laboratories of each member. The objectives of this work were 1) to determine precision of sieve analyses; 2) to detect common sources of error in sieve analyses; and 3) to develop a standard method for inclusion in *Cereal Laboratory Methods*. Results to date are presented and discussed below.

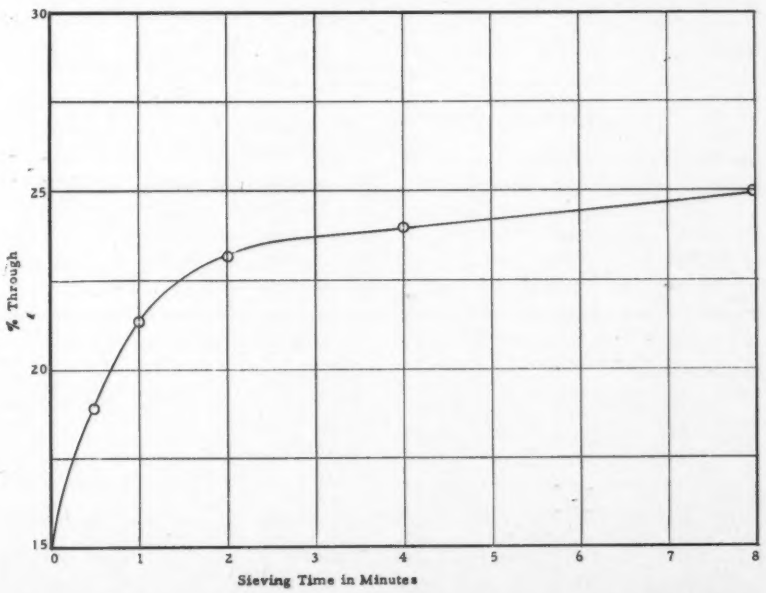


Fig. 1. Effect of sieving time (Ro-Tap) on percent through a No. 140 screen for whole-wheat flour.

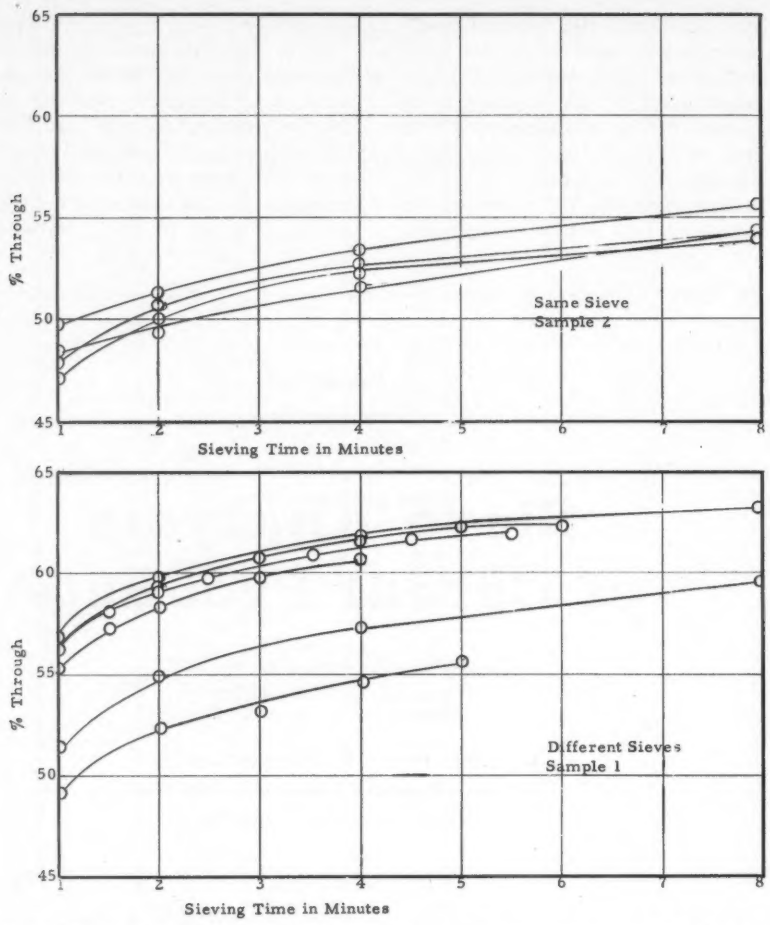


Fig. 2. Effect of sieving itme (Ro-Tap), sieves, and laboratory on percent through a No. 60 screen for whole-wheat flour.

Table I. Effect of Sieving Time, Sieve, and Laboratory Variation on Precision of Sieve Analysis

Sieving Time	*Standard Test Error, s*[a]					
	Reproducibility within Labs.		*Reproducibility between Labs, Same Sieve*		*Reproducibility between Labs, Different Sieves*	
	No. 60 Screen	*No. 140 Screen*	*No. 60 Screen*	*No. 140 Screen*	*No. 60 Screen*	*No. 140 Screen*
minutes						
1	0.99	1.04	1.15	1.65	3.45	3.00
2	0.75	0.80	1.03	1.19	3.29	3.21
4	0.77	0.98	1.02	1.00	3.24	...[b]
8	0.67	0.82	0.88	1.20	...[b]	...[b]
Over-all	0.82	0.93	1.00	1.28	3.32	3.12

[a] 2s corresponds to 95% confidence level.
[b] Insufficient data.

Experimental

Two samples of whole-wheat flour were sent to each member of the committee at different times. The first sample was subjected to triplicate sieve analyses using 60- to 140-mesh sieves available in the laboratories, and the second sample was analyzed with a 60-mesh and a 140-mesh sieve circulated among the members. In each case, percent through was measured after various time intervals. Tests were run in triplicate in each laboratory. Sieves were scrubbed with soap and water, rinsed well, and air-dried between runs. All weighings were to the nearest 0.1 g. After each sieving time interval, sieve and catch pan were weighed separately. All tests were conducted on Ro-Tap agitators, each collaborator using his own. It was stipulated that clearance between Ro-Tap lugs and cover plate be adjusted to 1/32-in. Sample sizes arbitrarily selected for these tests are given in the table below.

U. S. Standard Screen Size No.	*Sample Weight*
	g
40	50
60	50
100	25
140	10

Results for 60- and 140-mesh are plotted in Figs. 2 and 3, in which each dot is the mean result in a particular laboratory and each curve pertains to the results obtained in a particular laboratory.

Results and Discussion

In Fig. 2, all results with the same sieves are closely grouped, whereas results obtained with collaborators' sieves show considerable spread. Upon closer examination, it is seen that four of the curves with the collaborators' sieves are also closely grouped, and that two are considerably lower. Most, if not all, screen defects result in high rather than low results, so it must be concluded that the odd curves are due to poor cleaning methods. This would result in partial "blinding" and/or reduced opening size resulting from coating of the screen wire. These are results obtained with No. 60 sieves. Figure 3 was obtained in the same manner with No. 140 sieves. In this case similar conclusions can be drawn, except that, when collaborators' sieves are used, variations appear more random, suggesting that sieve-to-sieve variation is affecting results as well as cleaning method variation. Fairly good between-laboratory agreement is obtained when the same sieves and roughly the same procedure are used, but the amount of error introduced by sieves alone is disturbing.

A quantitative description of the effects of test variables on the reliability of sieving results is given by the standard errors calculated from the collaborative study data, Table I. In this table, within-laboratory error is below s = 1% through for all sieving times of 2 or more minutes. When the same

sieves are used, between-laboratory error is still below s = 1.25% for sieving times of 2 or more minutes. Thus, when sieve variations do not enter the picture, a single sieve analysis on whole-wheat flour should be reliable to ± 2.5% at the 95% confidence level. On the other hand, when each collaborator used his own sieve, the standard error for single analyses jumped to s = (about) 3.25%, making the reliability of single determinations at the 95% confidence level ± 6.5%. These figures include errors due to within- and between-laboratory variations. Although other factors doubtless influence results, it is clear that the major obstacle to *standardized* sieving results is sieve-to-sieve variation. The present 13% between-laboratory range is almost certainly too high for many of the purposes to which sieving results are put. Of course, as long as reliability within a single location is all that is desired, present results (±2.5% at 95% confidence level) are satisfactory except as individual sieves change with use. It is when between-company or between-location specifications are involved that this between-sieve discrepancy becomes serious.

Table II shows within-laboratory standard errors for three of the collaborators from whom sufficient data were available. Results from other collaborators appeared to fall within this range. The difference between collaborator 2 and the others appears to be significant, but this difference would not be of concern unless the large sieve-induced variation is controlled and unless, after this, still greater precision is desired.

Table II. Precision Variations among Collaborators (Standard Test Errors, s[a])

Collaborator	*Sieve Variations*		
	Same Sieve	*Collaborator's Sieve*	*Over-All*
1	1.23	0.77	1.03
2	0.53	0.46	0.50
3	0.84	1.26	1.06

[a] 2s corresponds to 95% confidence level.

The information reported above fulfills the first two objectives of the committee with regard to screen analyses in the range U.S. Standard No. 140 and coarser. The committee is working with other methods to obtain reliable results in the finer range. It is anticipated that the use of woven screens in the finer range would introduce even more sieve-to-sieve variation error.

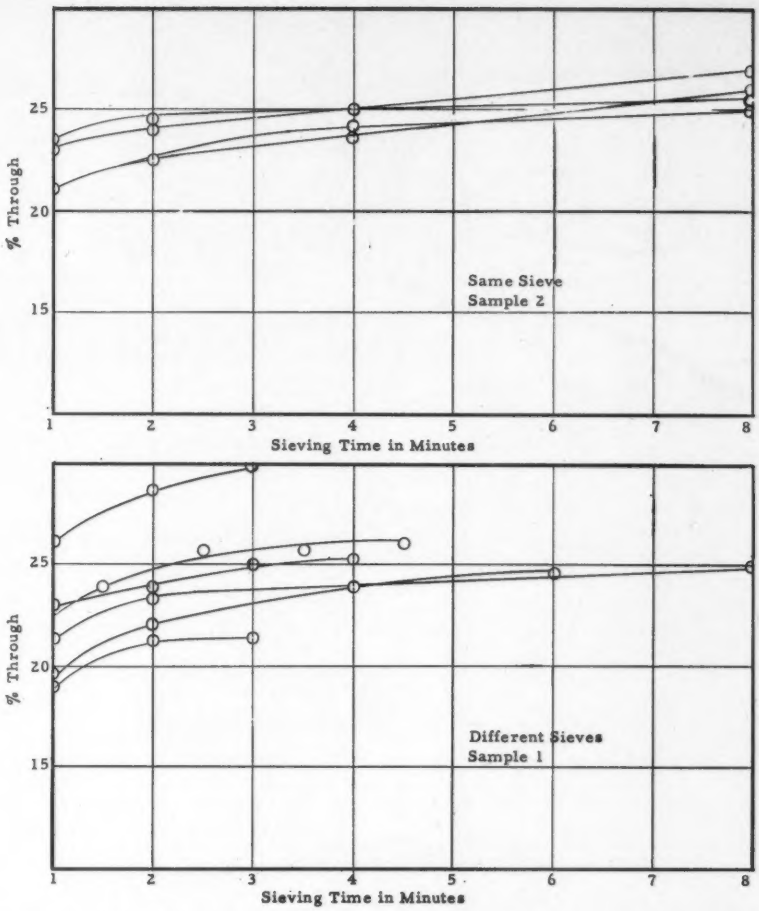
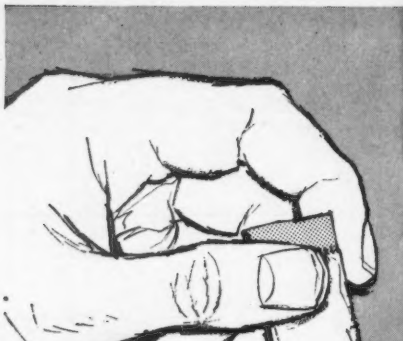


Fig. 3. Effect of sieving time (Ro-Tap), sieves, and laboratory on percent through a No. 140 screen for whole-wheat flour.

Before finalizing a procedure for *Cereal Laboratory Methods,* the committee plans to investigate means for reducing error introduced by sieve variations. Approaches include examining nonwoven sieves and exploring the mechanics required for a check sample service, utilizing a standard powder. Another problem with woven sieves is the fact that National Bureau of Standards specifications in the size range being considered permit a variation of ± 5% in the average opening. Tighter specifications on new woven sieves, therefore, would be necessary before any other action could be made effective. These avenues are being investigated, and results will be reported by the Committee as they are obtained.

Acknowledgment

The information reported above is the result of the joint efforts of all the members of the AACC Particle Size Committee. These include Ben Grogg, The Quaker Oats Co.; Merlin Anderson, Russell-Miller Milling Co.; Raymond Brown, International Milling; Paul Crowley, General Mills, Inc.; James Doty, Doty Laboratories; Frank Wichser, The Pillsbury Co.; and Avrom Handleman, Monsanto Chemical Co. The author and committee are indebted to K. Whitby, University of Minnesota, and R. R. Irani, Monsanto Chemical Co., whose contributions as advisors to the committee have been invaluable.



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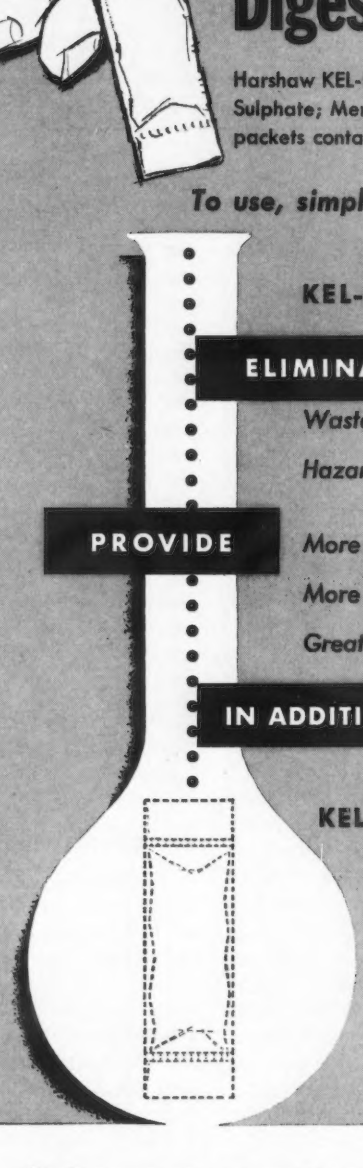

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How Various Techniques Contribute to

Particle Size Distribution Data

By Riyad R. Irani

Research Department, Inorganic Chemicals Division, Monsanto Chemical Company, St. Louis 66, Missouri

New techniques and modifications of older techniques for measurement of the particle-size distribution have increased over the past few years. This is primarily due to increased need for better characterization of powdered and granular materials. When a method based on a specific technique is to be adopted, it is important to compare the data with those obtained by other methods, particularly if one of these methods had been previously proved reliable. However, in making particle-size distribution comparisons, it is important to remember that the distributions should be expressed on the same basis, e.g., number-size or weight-size distribution (17).

Since the majority of powdered and granular materials used in industry include particles that deviate from sphericity, a working definition for size is needed.

Definition of Particle Size

The *size* of a particle is that dimension which best describes its degree of subdivision. For a spherically symmetrical particle, the diameter is that dimension, and therefore is its size. A *diameter* of a particle deviating from spherical symmetry may be defined as any one-dimensional distance between two points on the external surface of the particle which passes through the geometric center of the particle. For an irregular particle, a large number of non-equivalent diameters satisfying such a definition is possible, their average being the size of the particle. Irani and Ames (17) have shown that if the ratio of the largest to the smallest diameter of a particle does not exceed 3, then the size computed by taking the arithmetic average does not differ by more than 5% from that computed by taking the geometric average. Therefore, for a chubby, irregular particle, an absolute size is definable.

Methods of Measurement

Direct particle-size measurements, whether microscopic or otherwise, are the only known standard methods. Their major disadvantage had been the excessive time that had to be spent per determination. However, the development of electronic counters and sizers (which are, however, still relatively expensive) has eliminated this objection almost completely by shortening the time required per determination to a few minutes (3,39). Figure 1 shows that manual and electronic determinations using the microscopic technique are equivalent. Therefore, whenever possible, particle-sizing techniques should be compared with the direct methods.

For a chubby particle such as flour, Heiss and Coull (14) found that the settling velocity is surprisingly close (within 6%) to that of a sphere of equal volume. Therefore, if the size of an irregular-shaped particle is meaningful — i.e., the ratio of maximum to minimum diameter does not exceed 4 — then sedimentation methods should give results that agree with those from microscopy within experimental error.

The three major techniques for particle-size distribution measurement are microscopy, sedimentation, and sieving. Usually methods based on other techniques either are limited in scope or give only an average size. This paper will compare critically the various methods of particle sizing, and present data so obtained in this laboratory and by other investigators.

Tests for Dispersion

The problems involved in particle dispersion are common to all methods. Nevertheless, it is important to remember that as the particle size decreases, the surface electric charge on the particles increases, making proper dispersion difficult.

A recent paper by Michaels, Weaver, and Nelson (26) showed that spatulation is the most effective way to disperse particles. A small amount of the powdered sample is placed in a flat glass plate and a few drops of dispersion fluid are added; the powder is worked for a few minutes with a flexible spatula. Heavy pressure and a circular motion (frequently

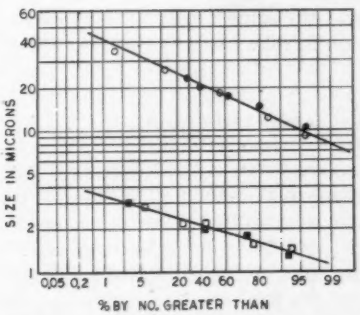


Fig. 1. Agreement between electronic and manual microscopic counting on two apatite sands: Circles represent sample 1 and squares, sample 2. Open characters, cintel data; solid characters, microscopic counting based upon ASTM E20-51T, 1951.

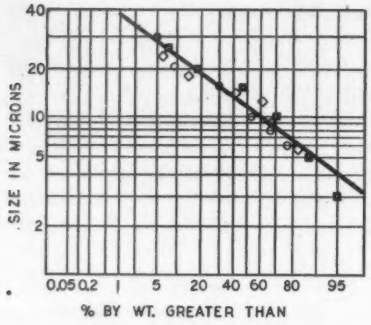


Fig. 2. Insoluble sodium metaphosphate: open circles, sedimentation in ethyl alcohol; solid squares, sedimentation in hexane; open diamond, sedimentation in isobutyl alcohol.

reversed) are used. Thereafter, the slurry is washed into a flask and more fluid is added until the concentration of the powdered material reaches the desired value.

Tests for proper dispersion are important because they are useful in deciding on the technique of dispersion, the sedimentation fluid, and concentration of dispersing agent (if any is needed). Several criteria for assessing the degree of dispersion have been described in the literature (4,31), and these depend on the difference in colloidal properties between deflocculated and flocculated suspensions (4). Making actual sedimentation runs is also helpful. In general, as the degree of dispersion increases, the percent fines increases. Moreover, reproducibility of the particle size determination is better when proper dispersion is achieved. Figure 2 illustrates that the particles of an insoluble sodium metaphosphate were dispersed to the same extent in several completely different fluids. This establishes that the proper degree of dispersion was achieved, since one would not expect the same degree of agglomeration to take place in various media.

Microscope Techniques

The advantage of microscope techniques is their directness. Most other techniques measure a property of the particle, and then through an equation calculate the size *per se*.

In making microscopic measurements, it is important to count and size enough particles so that a representative sample is considered. For materials with an average size of 50 μ or larger, not many particles will be present in the microscopic field, and to assure a statistically representative sample, many fields have to be counted. However, powders containing particles much larger than 50 μ can be counted by first photographically reducing the larger particles. The lower range of microscopic determinations is governed by the limits of resolution of the microscope. Thus, for microscopes using ordinary light, particles below half a micron cannot be detected. On the other hand, electron microscopes can resolve particles as small as 10-20 A, and the photomicro graph obtained can be counted.

Some Sedimentation Methods

Sedimentation methods utilize the dependence of the falling velocities of particles on their size, as first introduced by Stokes. Sedimentation methods can be logically divided into two different classifications: 1) those methods that utilize gravitational forces only, and 2) methods that utilize some sort of centrifugal field, e.g., an ultracentrifuge or a supercentrifuge.

Gravitational sedimentation methods can be divided into two categories. One includes those methods based on measurement of change in concentration at a given level; the more useful methods utilizing this principle are briefly discussed below.

The Andreasen pipet method involves relatively simple apparatus (5,6). Small samples of suspension are pipetted during sedimentation, and the concentration of particulate matter is determined either volumetrically or gravimetrically. The pipet method has been widely used because of its simplicity of operation and the low cost of its hardware. However, it has inherent errors. The continuous removal of sample from the suspension considerably disturbs the sedimentation medium and falsifies a basic assumption of Stokes' law, namely, that sedimentation is proceeding under steady-state conditions. Also, since dilute concentrations must be employed in sedimentation techniques, a large sample must be removed to accurately determinte the particulate concentration. Such removal causes a change in sedimentation height, which should be corrected for.

Sedimentation: Diver Method

The diver method was first developed by Berg (9). The method makes use of small glass divers of known density which are inserted into the suspension and allowed to settle to the level at which the density is equal to that of the diver. They continue to sink at this density level as sedimentation progresses. Each diver contains a metallic or heavy strip and is weighted to the required density with alcohol. The divers are small (about 7 mm.) and no stem breaks the surface during a run, so that errors due to surface tension are eliminated. Measurements can be made at very small depths from the surface of the suspension so that particles as small as 0.2 μ can be measured. The major disadvantage is that the divers are not usually visible in the suspension because of their small size, so that they have to be located by attracting them to the wall of the glass sedimentation tube, for example by means of a magnet, thus disturbing steady-state sedimentation.

Sedimentation: Hydrometer Method

The hydrometer method was developed by several investigators (10,21,22). In this method it is assumed that the difference in density between suspension and pure fluid, as measured with a hydrometer, is proportional to concentration. The major problem is to decide at what point on the hydrometer the concentration of particulate matter corresponds to the hydrometer reading. The position of this level is somewhat indeterminate, and since the hydrometer sinks as sedimentation proceeds, the position is not constant. Other shortcomings of the hydrometer method are the deposition of material on the hydrometer and/or the disturbance of steady-state conditions when the hydrometer is inserted and removed from suspension. In addition, since part of the hydrometer is in the air, surface-tension correction should be applied.

Several authors (11,23,24,32) tried specific adaptations of the

hydrometer method. Technical associations have published detailed descriptions of hydrometer methods for particle-size determination of clay mills. Of these, the most complete are those of the Technical Association of the Pulp and Paper Industry (35) and the American Society for Testing Materials (2). The first deals specifically with paper clays and makes use of a nomograph for solution of Stokes' law. The ASTM procedure is designed for the analysis of soil but contains tabular data that make preparation of calculation charts easier.

Sedimentation: Manometers

Manometers have been used to follow the sedimentation of particulate matter in a suspension. In one type of the apparatus, the difference in height between pure fluid in a vertical side tube and the suspension is measured at various times. This gives the variation of the mean density of the suspension between the surface and the sampling level. The method is rather insensitive because of the slow change of excess height. Moreover, the experimental data have to be differentiated twice before the particle-size frequency curve is obtained. The manometer method tends to be sluggish in action and the fluid can get contaminated with the powder which has migrated from the sedimentation vessel. Differential manometers (21) have also been used, with the advantage that the mean density over a thin slab of suspension is measured, eliminating one differentiation step.

The activation analysis method utilizes the activity induced in the particles by neutron bombardment to measure the amount of the material in a lamina of suspension. During irradiation, the activity induced in a particle is proportional to the number of atoms in the particle. Consequently, relative inactivity between two particles is equal to their relative weights. Similarly, in a lamina of suspension, the relative activity at any time is proportional to the weight concentration of particles in that lamina. A peculiar advantage to this technique is that it can be used to determine the particle-size distribution of components in a mixture, through discrimination of the respective radiations (1,8). Limitations to this method are the special handling and disposal of isotopes that have to be considered. As with other radiochemical techniques, counting statistics and scattered radiation limit the accuracy of the method.

Sedimentation: Photometry

In the photometric method (29, 30), a parallel beam of light, of small vertical depth compared to the distance of the beam below the surface of the suspension, is projected across the suspension onto a photoelectric cell. Readings of the emergent light intensity are taken at known times while the powder settles out under the influence of gravity. One advantage of this method is that the size distribution is obtainable by integrating rather than differentiating experimental data. In addition, a recording automatic apparatus may be constructed, as was done by Talvite and Paulus (34). However, in the calculations the assumption has to be made that the light cut off by a particle is equal to its projected area, regardless of its size or chemical composition. This assumption is often unjustified and it is necessary that the relation between the absorbance and particulate concentration be known for each powder over a wide range of particle size prior to a run with an unknown sample.

Cumulative Sedimentation

The basic principle for cumulative sedimentation techniques is to measure the amount of particulate matter that settles a specific distance versus time. At the beginning of a measurement, the particulate matter can be either homogeneously distributed or concentrated in a layer of suspension on top of the actual sedimentation fluid.

If particulate matter is initially concentrated in a *layer* whose thickness is small compared to the distance below the surface at which the amount settled is measured, then particle-size distributions can be directly obtained through the use of Stokes' equation and a simple calculation of the ratio of the amount settled at any time to the total weight of the sample.

Eadie and Payne (13) developed a commercial instrument (Micromerograph) which utilizes the layer sedimentation principle in air. Although the advantage of speed of operation is obvious, uncertainties in air sedimentation are usually serious. Thus, no check can be made if proper dispersion of the particles was obtained, and in many cases it is not achieved. It is also well known that particles acquire a high surface charge during motion in air and, indeed, in extreme cases 30% of finely divided powders during a determination have been found to stick on the walls of the sedimentation vessel. Since surface charge is dependent upon relative humidity of the room, chemical composition, and particle size, a nonrepresentative sample often reaches the bottom of the sedimentation column for measurement. Also, the limits of Stokes' equation are significantly narrowed in air sedimentation because of particle slippage, caused by the large mean free path for gaseous molecules.

Other Sedimentation Techniques

The Werner (36), Palo-Myers[1], and Travis methods also operate on the layer technique, but utilize a liquid suspension on top of a column of free liquid. Several objections to these crude apparatuses can be listed; the most important is the effect of eddy currents (density streaming) that cause particles in the suspension to settle through mixing, aside from normal sedimentation.

Whitby (38) eliminated two major complications from the layer technique by using a feeding suspension (the layer) that has a lower density but a higher viscosity than the clear sedimentation liquid; the adverse effect of density streaming is minimized, and all particles do start from the same point. Whitby also utilized a streamlined sedimentation tube and a "tapper" to minimize sticking of particles to the entrance of the capillary at the bottom of the sedimentation tube.

The homogeneous suspension-sedimentation method involves

[1]Palo-Myers, Inc., New York; bulletin on particle size apparatus.

measurement of the over-all concentration change in a suspension as a function of time. The measurement of over-all concentration can be determined with manometers or by difference, using a balance pan at the bottom of the sedimentation vessel.

Manometric methods are suspect because it is difficult to measure accurately the small pressures produced by low concentration, and because of the return of clear liquid from a side arm. The sedimentation balance, on the other hand, is free from these defects. Owing to the great sensitivity of the sedimentation balance method, a very low concentration may be used. The only factor that could cause interference with the settling is the movement of the balance pan, and this can be minimized greatly by proper choice of balance. Another advantage of the sedimentation balance method is that a recording balance can be utilized. Rabatin and Gale (28) described a simple recording sedimentation balance. They utilized a sensitive spring to weigh the particles on the pan. As the weight on the pan increased, a shutter mechanism directly attached to the spring intercepted a parallel light beam that was focused on a photocell, the change in photocell current being automatically recorded. Ames *et al.* (3) attached a torsion wire to a balance pan situated at the bottom of a sedimentation column and used a linear variable differential transformer to generate a voltage signal that was amplified and recorded; the recorder reading was proportional to the weight settled. Bachman and Gerstenberg (7) evaluated a commercial recording sedimentation balance (Sedibal Recorder) and found that it gave more precise results than the Andreasen pipet method.

The use of centrifugal sedimentation for the measurement of particle size is complicated by the fact that unless the layer method is utilized, very involved integrals must be evaluated (33). Marshall (25) was the first to utilize the layer technique. However, Whitby and co-workers (38) were the first to describe a workable centrifugal method, that has been commercialized under the trade name of MSA Particle Size Analyzer. Basic to the method are specially designed centrifuges that have speeds constant to within 1%, so that speed vs. time curves during starting and stopping are known and constant enough that corrections do not vary by more than ± 0.5 second. In this method, sediment height is assumed to be proportional to sediment weight. When particulate matter is completely dispersed this is a good assumption because monosized particles are essentially settling at any one time, and void space is independent of size. However, in many cases, strong aggregates of smaller particles exist; compression of the sediment column with increasing centrifuge speed and time takes place, and bulk density correction factors must be used.

Several classifiers and elutriators are commercially available and have been described in the literature. However, these instruments give particle-size fractions that are not very sharp. Therefore, they are more useful in obtaining size cuts than in measuring size distributions.

Sieving Techniques

Sieving, one of the oldest methods for measuring particle-size distribution, is the most popular because of its simplicity of operation and relatively inexpensive apparatus. However, as shown by Daeschner *et al.* (12), woven sieves tend to deform upon use. For mesh openings over 100 μ, these deformations do not seriously affect the size distribution analysis. For mesh openings of about 275-mesh or finer, woven sieves may not be sensitive enough to pick up fine differences between samples. The introduction of electroformed (micromesh) sieves (12) has made sieving applicable in particle-size ranges as low as 10 μ. These sieves have permanent joints, so that no change in the size of opening takes place with extensive use. It has been well established by the AACC Particle Size Committee that nonuniformity of woven sieves contributes much more to the error of determination than interlaboratory or interanalyst variations. Therefore, the introduction of micromesh sieves is a significant break-through in sieving technology.

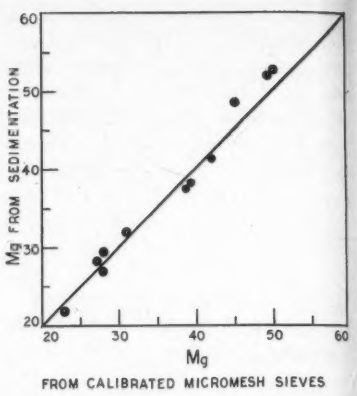


Fig. 3. Agreement between calibrated micromesh sieves and sedimentation for several calcium phosphates. Mg is the geometric mean diameter on a weight basis, in microns.

The addition of 1–2% of a flow-conditioning agent, such as tricalcium phosphate, has been found to enhance the rate of sieving (20) because of the improved flow properties (18).

Whitby (38) and several other investigators have established that the mechanism of sieving includes two steps. In the first step, particles that have a size equal to or smaller than 70% of the opening of the sieve pass through with ease. In the second and much slower step, particles whose size is between 70 and 100+% of the sieve opening pass through. To avoid prolonged sieving for fine materials, but yet get meaningful size distributions with sieves, whether micromesh or woven, sieves must be calibrated. These calibrations are only good for a specific material, sieving procedure, time of sieving, and sample size.

Figure 3 shows that agreement was obtained between the sedimentation balance technique and calibrated micromesh sieves (15). Table I shows that microscopy and the sedimentation balance method give the same particle-size distribution when both are compared on the same basis, whether number-size or weight-size.

Figure 4 is a comparison of the data obtained on two different samples of flour using microscopy, gravitational sedimentation, centrifugal sedimentation, the Coulter Counter, sieving by brushing, sieving with a Ro-Tap and a conditioning agent. The data indicate that except for the Coulter Counter method, the techniques agree

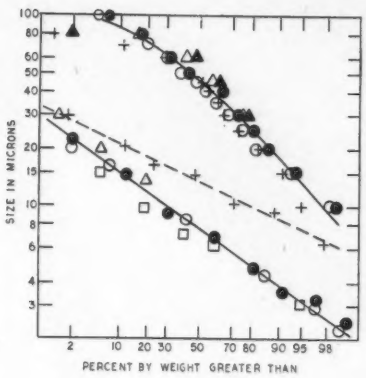
Table I. Agreement between Particle-Size Distributions from Microscopy and Sedimentation

Material	*Dispersion Fluid*	*Geometric Mean Size on a Weight Basis from*	
		Microscopy	*Sedimentation*
		μ	μ
Sand Glass beads	Water	20.7	21.2
	Butanol	32.5	31.0
Anhydrous monocalcium phosphate	Isobutanol	43.5	45.0
Tricalcium phosphate	Ethanol	3.9	3.5
Calcium pyrophosphate	Ethanol	7.9	8.4

with one another within experimental error. Deviation of the Coulter Counter from other techniques has been observed for materials other than flour (16,27).

The diagram is a resume showing the region of applicability of the various techniques. The adoption of one method in preference to another must be based on several considerations. Precision and accuracy required, cost of equipment, time per analysis, and caliber of technicians are only a few of these factors.

Fig. 4. Intercomparison of methods for the particle-size distribution measurement of flour. Legend: solid circles, microscopy; open circles, gravimetric sedimentation; plus symbols, Coulter Counter; open triangles, sieving-brushing; solid triangles, Ro-Tap sieving with 1% tricalcium phosphate; open squares, centrifugal sedimentation.



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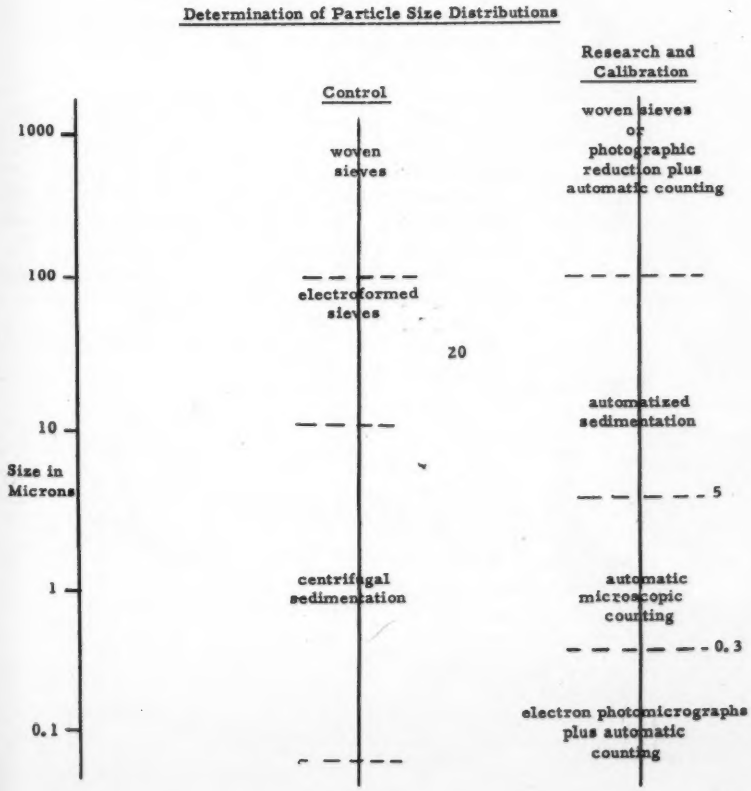

AACC Adopts Standard

Farinograph Curve Characteristics

By W. C. Shuey
Chairman, Physical Testing Methods Committee, AACC

THREE YEAR'S work is now culminating in a service which the Physical Testing Methods Committee believes fills a need of all cereal chemists who use the farinograph—a mixer calibration program.

After the introduction of the constant flour and constant dough weight methods for farinograph testing of flour in the Sixth Edition of *Cereal Laboratory Methods,* the committee focused its attention on interlaboratory accuracy and precision. Early in 1957 six collaborators tested 12 coded samples (six different flours) by the constant flour and constant dough weight methods with small and large size farinograph mixers. This lengthy work clearly showed that interlaboratory differences may be traced to the mixer calibration and/or the farinograph itself. Thus the work for the committee was obvious—determine what is the most desirable calibration of mixers; i.e., what curve shapes are most commonly associated with particular types of flours.

Problems Involved

When one considers this for a moment the complexity of solving a simply stated question becomes apparent. The judgments must be made from experience, experience drawn from the use of particular farinograph mixers. These mixers in use may have been old or new; purchased with manufacturer's recommended calibration settings; or the calibration may have been supplied to the farinograph user's specifications. The mixers also may have been damaged, unknown to the owner. These and many other factors may affect a person's opinion of curve characteristics associated with particular types of flours.

Because of vested interests in a particular calibration, such as operating decisions made over the years based on particular curve shapes, it could be expected that opinions as to the desired calibration would be quite strong. Despite the subjective nature of the decision to be reached ultimately, the committee worked toward a satisfactory decision which it felt would meet the needs of the AACC membership.

Selecting the Curve

The committee, in cooperation with the manufacturers, tested several mixers on flours covering the normal range of mixing properties from very short development time soft wheat flours to very strong high-gluten flours. From these curve charactertistics from different calibration settings the committee chose that which they considered to be the most desirable shape for North American usage. Rather than limit this judgment to the committee members, a questionnaire was drawn up utilizing the anonymous curves of certain flours representing the calibrations (curve shapes) obtained. The results of this survey of approximately twenty-five farinograph users drawn from the AACC's National Check Sample Service supported and confirmed the judgment of the committee as to the desirable calibration or curve shapes.

At this point two problems had to be faced: assist the manufacturers to clearly understand the type of curve characteristic desired and work with them to attain this calibration; and secondly, to arrange the specification and control of the AACC-recognized calibration.

The first problem was an awkward one since flours had to be shipped great distances, curves exchanged, and mixers tested. This took time and a great deal of work. The second was more difficult. Normally the performance characteristics or rather the calibration of a test apparatus can be specified with objective specifications, that is, specifications as to material, dimensions, finish, and similar attributes. In this case because of differences in manufacturing techniques, materials, and other aspects, a uniform specification on all counts would severely restrict both manufacturers. The rigid duplication of mixers from all standpoints would have delayed the program for many years. It was therefore agreed by all that performance or uniform curve characteristics was the desired expedient solution to the problem. Therefore, conformance to curve charactertistics should be the basis of judgment (without regard for rigid dimensional, material, or construction specifications) for the mixer as the initial phase in the standardization of farinograph bowls. An analogy of this situation can be made in the calibration of such items as thermometers and viscometers which must be tested for conformity to standards.

The committee approached industrial testing laboratories in the immediate area of the manufacturers. The proposal of the United States Testing Laboratories was ac-

cepted by the committee and the manufacturers and approved by the Board of Directors of the AACC.

The Program

On February 1, 1961, the program of sale and certification of large farinograph mixers will be initiated. In effect the purchaser may request of either manufacturer large farinograph mixers with a calibration of curve shape to meet AACC specifications. The cost of certification will be charged by the manufacturer to the customer. The cost will be $52. A five-pound sample of a standard flour will be available at $10.

Certification will consist of testing the mixer by Cereal Laboratory Method 26.4.1 or 26.4.2 whichever is requested by the customer. The mixer will be tested with two flours which will be a hard red winter flour of medium mixing time four to six minutes and a spring wheat flour of longer peak time, six to nine minutes. The curves of these two flours and the curves of the AACC reference mixer will be forwarded to the customer and manufacturer if found acceptable. An overlay transparency of the curves also will be provided. A five-pound sample of flour from the same batch taken on the day of the testing will be available if desired at a cost of ten dollars. The certification agency will have available two working reference standard mixers. A third mixer of the same curve characteristics will be retained by the AACC and not be used unless required to check the working standards. This third mixer will be the primary reference standard mixer.

A certification seal will be affixed to the mixer and the mixer dispatched to the customer. Thus the customer, at the time of purchase, is assured that his mixer meets the standard of the AACC Physical Testing Methods Committee. By testing with two flours a reasonable assurance is made that the mixer will perform comparatively to other certified mixers over a limited but useful spectrum of flour types. The experience of the committee over the last three years indicates that problems can only arise with extreme flour types, if the mixers have been checked on two flours.

The cereal chemist who has not considered replacing his mixer, but wants to know his calibration position, will have two courses open to him. The first is to submit his mixer to the United States Testing Company for a certification test at the cost of the service plus shipping in both directions. The second would be to order the test flours and their curves from the certification agency in order to compare the results with a bowl in question. The latter course, however, does not eliminate farinograph dynamometer differences, operator error, and/or other factors and thus might be less desirable.

The testing of a mixer will be done on a farinograph of the 62-63 r.p.m. shaft speed, which is the most common in use. Some differences will be seen if the mixers are used on the single-speed models of 60 r.p.m. The slower-speed machine will give slightly longer curves (approximately 1 minute on stability) and ½% lower in absorption with the same bowl and flour.

The Future

Certification will not solve all the interlaboratory discrepancies since method deviation, operator technique, and condition of the farinograph will affect interlaboratory comparison. If care is given to using the methods as described in *Cereal Laboratory Methods* and the condition of the equipment is good, then a great improvement in interlaboratory comparison can be expected.

It must also be recognized that damage to a mixer during use or undue abuse may affect its calibration. It becomes necessary then, if good checking with others is to be maintained, to be alert to changes in mixing curve characteristics. It will now be possible to check with other laboratories or the United States Testing Company if deviations are suspected.

The availability of mixers of the same calibration, a calibration which is the expression of the cereal chemists, is a great step forward. The committee and the manufacturers, Mr. C. W. Brabender and Mr. Arthur Hartkopf, have worked hard to bring this program into existence. It is hoped that the needs of the cereal chemists have been properly reflected in this accomplishment and that the program will get the active support of those who use the farinograph for flour testing.

Ultimately it is hoped that farinograph mixers can be specified objectively and thus produce the desired curve characteristics. To this end the committee and the manufacturers will be working, but in the meantime a workable service to bring about the much needed constant mixer calibration is available for your use. YOU ARE URGED TO GIVE YOUR ACTIVE SUPPORT.

IMPORTANT NOTICE!

for

all Technical Committees

The AACC's Technical Committees have the prime responsibility for recommending methods to be included in *Cereal Laboratory Methods*. On January 22, I met with the Methods Revision Committee to discuss the "progress" of the 7th edition. Most of the methods have been submitted. The revision committee now has an enormous task to complete prior to the Dallas meeting in April.

Will you please do what you can to finish up your methods and send them in within the next few days, OR if you have a method which is imminent but which will be delayed, please submit it by title NOW.

KENTON L. HARRIS, *Chairman*
AACC Technical Policy Committee

To Farinograph Users, Everywhere

RE: CERTIFIED C W BRABENDER MIXERS

C. W. Brabender will deliver to you, "whenever you say" a certified Mixer meeting the official AACC standard. Certification will be made by a leading testing laboratory ... U. S. Testing Company, Hoboken, N. J. ... if you so specify. Our mixers are built to pass the test "with flying colors". And now, here is the BIG NEWS ...

RE: NEW C W BRABENDER Lease-a-Flour-Mixer Plan

For only $169 per year, you get ...

1. A C.W.B. Farinograph Flour Mixer ("bowl") calibrated to the AACC standard.

2. Free calibration of the Farinograph, on which the Mixer is to be used, F.O.B. "us".

3. Free Mixer calibration correction to the AACC standard at any time if deviation* occurs.

4. Free Calibration Check Kit (flour and Farinogram), F.O.B. "us" any time you want it.

5. Free Mixer loan while your damaged Mixer is being repaired. Shipped within 24 hours.

PLUS ... A New Leased Mixer Furnished Free Every 3 Years!

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Megaton Weapons Introduce

The Menace of Fallout

FALLOUT, A NEW term in our vocabulary since 1945, assumed staggering importance with the advent of the hydrogen nuclear device. Its relationship to the food industry will be discussed at the Civil Defense Training course to be conducted for the food industry, by the U.S. Food and Drug Administration, following the AACC annual meeting in Dallas, Texas, April 13-14, 1961.

Fallout is the radioactive debris from a nuclear weapon. It consists of radioactive bomb residues made up largely of fission products which condense into very small solid particles. Some 200 different radioactive isotopes result from a fission explosion. Our interest in fallout is that it is harmful to man.

Fallout is hazardous because it contains radioactive material which, during the course of its radioactive life, continuously gives off radiation capable of harming all living matter. When the first 20,000-tons-TNT-equivalent nuclear fission weapons were the standard nuclear weapons, fallout was relatively unimportant because it traveled comparatively short distances, and total activity was not sufficient to make any large areas uninhabitable for long periods.

The situation changed entirely with the successful detonations of the fission-fusion hydrogen weapons at Eniwetok in 1952, and later with detonation of the fission-fusion-fission or so-called "dirty" weapon in 1954. We now know that hazardous radioactive fallout can contaminate an area of several thousand square miles downwind, with lethal doses for all unprotected people, during the first 36 hours following the detonation of the weapon. Large amounts of extremely minute radioactive particles move into the stratosphere where they blanket the earth and continue to fall for years. However, our concern is with the great quantities of lethal radioactive fallout material that settles out during the first post-attack hours and days.

Many food-manufacturing plants have skylights with louvered sides or screen in the spaces between the walls of the plant and the roof, which can readily admit fallout. Complete protection from fallout would involve airtight security of a building, including pressurized interiors. While this may be next to impossible to obtain, largely owing to the greatly increased cost of construction, and to the impracticability of maintaining this situation during and immediately after an attack, efforts should still be made to make food plants more nearly dustproof. From a practical viewpoint, fallout may be considered to be radioactive dust. When it can be kept outside of buildings the hazard is reduced to radiation from the fallout material. If the fallout comes inside the building, it can get into the food being processed and can also become both an external and internal hazard to the employees.

The stages of the food-processing line which are most vulnerable to fallout contamination will be pointed out by the instructors with the aid of moving pictures and film taken in a processing plant.

Fallout on growing crops is also a serious problem. Fruit and vegetables harvested immediately after an attack will present only the problem of external contamination. The same items harvested weeks or months later may have internal contamination from absorption through the roots and leaves of the parent plants. While some contamination may be permitted in food during the emergency on a calculable risk basis, it is unlikely any will be permitted under normal nonemergency conditions. There is no known way of removing radioactive material from processed food once it has become mixed with or becomes an integral part of that food.

Fallout must be kept out of our food-processing plants, their processing equipment, the packaging materials, the food itself, and off and out of the people who work in the plant. Suggestions for accomplishing these difficult and important tasks will be offered during the Civil Defense Training Course. Several methods of disposal of fallout and fallout-contaminated food will be presented, along with methods of removing fallout from the exterior and interior of the food-processing plant and its processing machinery.

Fallout's death-dealing capabilities can be greatly curtailed if we know what action to take, when and if a nuclear attack is made on our country. It is extremely important to know the *right* action to be taken when the emergency occurs. While all people need to know how to survive the initial phases of an atomic attack, it will be largely the responsibility of technical personnel in a food-processing plant to direct the decontamination operations required before the plant can again be used.

The Food and Drug Administration's Civil Defense Training Course in Dallas, Texas, April 13-14, 1961, following the annual AACC meeting will present some of the problems and give some possible and practical solutions.

PRELIMINARY PROGRAM

46th

ANNUAL MEETING

☆ ☆ ☆

AMERICAN ASSOCIATION OF CEREAL CHEMISTS

April 9-13, 1961

BAKER HOTEL • DALLAS, TEXAS

GENERAL PROGRAM

Sunday, April 9

Registration
12:00 noon
Editorial Board Meeting
1:00 p.m.
Board of Directors Meeting
2:00 p.m.
Technical Policy Committee Meeting
4:00 p.m.
President's Reception
8:00 p.m.

Monday, April 10

Registration
8:00 a.m.
Exhibits
9:00 a.m.
Opening Session
9:30 a.m.
CEREAL SCIENCE TODAY STAFF MEETING
12:00 noon
Technical Sessions
1:30 p.m. Concurrent — Crystal Ballroom and Texas Room
Texas Barbecue and Rodeo
5:30 p.m. Buses leave hotel for ranch

Tuesday, April 11

Registration
8:30 a.m.
Exhibits
9:00 a.m.
Technical Sessions
9:00 a.m. Concurrent — Crystal Ballroom and Texas Room
1:30 p.m. Concurrent — Crystal Ballroom, Texas Room, and English Room

Wednesday, April 12

Registration
9:00 a.m.
Exhibits
9:00 a.m.
Technical Sessions
9:00 a.m. Concurrent — Crystal Ballroom and Texas Room
National and Sectional Officers Luncheon
12:15 p.m.
Technical Committee Meetings
1:30 p.m. Concurrent
Board of Directors Meeting
3:00 p.m.
Cocktail Party (sponsored by Allied Trades)
6:00 p.m. Crystal Ballroom
Banquet and Dance
7:00 p.m. Terrace Room

Thursday, April 13

Exhibits
9:00 a.m.
Technical Sessions
9:00 a.m. Concurrent — Crystal Ballroom and Texas Room
Annual Business Meeting
11:30 a.m. Crystal Ballroom
Adjournment
12:00 noon
Civil Defense Training Course
1:30 p.m. Food and Drug Administration Office

Friday, April 14

Civil Defense Training Course
9:00 a.m. Food and Drug Administration Office
1:30 p.m. Food and Drug Administration Office

LADIES' PROGRAM

Sunday, April 9

2:00 p.m. Ladies Hospitality in Rooms 1 & 2, Mezzanine
8:30 p.m. President's Reception — Terrace Room

Monday, April 10

8:30 a.m. (Hospitality Rooms open all day) Continental Breakfast — Rooms 1 & 2 (Courtesy Chas. Pfizer Co.)
11:30 a.m. Luncheon — Ports of Call Top of Southland Life Co. (Courtesy Durkee Famous Foods)
5:30 p.m. Bar-B-Que and Rodeo (Transportation to be provided)

Tuesday, April 11

8:30 a.m. Continental Breakfast — Rooms 1 & 2 (Courtesy Sterwin Chemical)
10:00 a.m. Tour of the City of Dallas
1:00 p.m. Luncheon — La Tunisia Restaurant (Courtesy Merck & Co.)

Wednesday, April 12

8:30-12:00 a.m. Hospitality Room open
8:30 a.m. Continental Breakfast — Rooms 1 & 2 (Courtesy Pope Testing Labs)
11:30 a.m. Luncheon — Neimen-Marcus Co. (Courtesy Wallace & Tiernan Co.) Tour of the Store
7:00 p.m. Banquet & Dance — Terrace Room

Thursday, April 13

8:30 a.m. Continental Breakfast — Rooms 1 & 2 (Courtesy Lone Star Section)

TECHNICAL PROGRAM PAPERS

Chemical Residues in Cereal Products

The Migratory Potential of Volatile Packaging Components
KENNETH MORGAREIDGE and ROBERT D. KROSS, Food and Drug Research Laboratories, Inc., New York

Bromide Residues in Cereal Products Resulting from Experimental Fumigations with Methyl Bromide
M. E. GETZENDANER, The Dow Chemical Co., Midland, Michigan

Fungicides on Grains: Food and Drug Administration's Methods and Policies
NORMAN E. FOSTER, U.S. Food and Drug Administration, Dallas

Panel Discussion by Authors with Questions from the Floor

Flavor Research

Effect of Processing Variations on the Alcohol, Carbonyl, and Organic Acid Contents of Pre-Ferments for Bread Baking
E. W. COLE and J. W. PENCE, Western Regional Research Laboratory, Albany, California

Characteristics of the Yeast-Leavened Flavor of Baked Goods
SIMON S. JACKEL and ELEANOR ERSOY, Vico Products Company, Chicago

Identification of Carbonyl Compounds Produced in Preferments
BYRON S. MILLER, JOHN A. JOHNSON, and ROBERT J. ROBINSON, Crops Research Division, U.S. Department of Agriculture and Kansas State University, Manhattan

Why Is Flavor Research Desirable in the Bread Baking Field?
LAZARE WISEBLATT, American Institute of Baking, Chicago

Panel Discussion

Laboratory Layout

Work Measurement and Control in Quality Control Laboratory Operations
JOHN M. DUNTLEY, The Pillsbury Co., Springfield, Ill.

Baking Laboratory Layout and Procedures
T. R. AITKEN and R. H. KILBORN, Grain Research Laboratory, Winnipeg

Simple Methods for Planning Your Laboratory Space
ARTHUR W. CARLSON, E. H. Sheldon Equipment Co., Muskegon, Mich.

Feed Technology Session No. 1

Biochemical and Biological Measures of the Effect of Pelleting on Starches
W. H. HASTINGS, G. D. MILLER, and MUHAMMAD AKRAM, Kansas State University, Manhattan

Determination of Supplemental Enzymes in Feed Products
P. H. DERSE, Wisconsin Alumni Research Foundation Laboratories, Madison

A Procedure for the Determination of Supplemental Alpha-Tocopheryl Acetate in Premixes and Feeds
F. H. TINKLER and S. R. AMES, Distillation Products Industries, Rochester, N.Y.

Xanthophyll Variation in Hybrid and Inbred Corn — Improved Methodology
C. W. BLESSIN and R. J. DIMLER, Northern Regional Research Laboratory, Peoria

The Thiobarbituric Acid Test — Its Application as an Analytical Tool for Measuring Quality of Feed Products
E. F. BUDDE and E. NEHRING, Quaker Oats Co., Barrington, Ill.

Statistics of Distribution of Colored Tracer Particles in Ideal Systems and in Feeds
S. EISENBERG, L. C. THOMPSON, and J. LEICHTER, Anresco, San Francisco

Discussion

Chemistry and Technology of Yeast

Influence of pH on Yeast Fermentation in Baking
SUTTON REDFERN, SEYMOUR POMPER, and JOHN A. MASELLI, The Fleischmann Laboratories, Stamford, Connecticut

Production of Fodder Yeast from Barley
KENNETH J. GOERING and M. J. HOULE, Montana State College, Bozeman

Some Observations on Varying Sugar Additions in a Simulated Continuous Mix Process
H. F. ZIEGLER, ROBERT D. SEELEY, and H. J. BUEHLER, Anheuser-Busch, Inc., St. Louis

The Warburg Respirometer for the Study of Yeast Fermentation of Bread Doughs
WILLIAM A. HARDWICK, Anheuser-Busch, Inc., St. Louis

The Effect of Some Common Chemicals on Liquid Ferments
P. E. SNELL and KARL L. FORTMANN, Baker Process Company, Belleville, New Jersey

Use and Production of Baker's Yeast in Various Parts of the World
OSWALD FREUND, Red Star Yeast & Products Company, Milwaukee

Physiological Changes in the Viable Cells of Aging Active Dry Yeast
ERICH SCHULDT, National Yeast Corporation, Belleville, New Jersey

Feed Technology Session No. 2

Feed Spoilage and Its Control in Mixed Feeds
L. R. RICHARDSON and B. D. WEBB, Texas A and M College, College Station

Feeds and Feeding in Old Mexico
HARRY KONEN and JOHN R. WATKINS, Harry Konen and Company, Houston

Statistical Quality Control of Feeds
LEONARD KRESOYA and R. C. SETTERGREN, General Mills, Inc., Minneapolis

Feed Microscopy in Quality Control and Feed Microscopy Short Course
EWING E. BROWN, Texas A and M College, College Station

Practical Applications and Problems of Feed Nutrition
HARRY GERMAN, Texas Farm Products Co., Nacogdoches

Colored Sound Film Entitled "Bulk Flow of Materials in Bins"
ART STEGNER and DONALD SHIMON, Butler Manufacturing Company, Kansas City, Missouri

Discussion

Continuous Breadmaking

Laboratory Equipment for the Evaluation of Ingredients and Factors Relative to the Continuous Processing of Dough
K. L. FORTMANN and J. S. BALLARD, Baker Process Company, Belleville, New Jersey

Modern Understanding of Dough Development and Baking Chemistry Applied to Continuous Dough Processing
ERIC G. SNYDER, Consultant, American Machine and Foundry Company, East Orange, New Jersey

Factors Affecting Quality and Their Control of Flour for Continuous Breadmaking Processes
D. B. PRATT, JR., Pillsbury Company, Minneapolis

Panel Discussion

Starch Chemistry

Measurements on Starch Gelatinization
J. W. SULLIVAN, J. A. JOHNSON, and B. S. MILLER, Kansas State University, Manhattan

Use of a Freezing Pretreatment in the Separation of Amylose from Amylopectin of High-Amylose Corn Starch
EDNA MONTGOMERY, K. R. SEXSON, and F. R. SENTI, Northern Regional Research Laboratory, Peoria

A Method for the Determination of Relative Amounts of Cereal, Fungal, and Bacterial Alpha-Amylases in Mixtures
JAMES R. FLEMING, BYRON S. MILLER, and JOHN A. JOHNSON, Kansas State University, Manhattan

A Comparison of the *In Vitro* Digestibility of High Amylose Corn Starches with That of Other Starches
R. M. SANDSTEDT, S. UEDA, and DONNA STRAHAN, University of Nebraska, Lincoln

Chemistry and Technology of Flour

A Novel Bread-making Technique
J. G. PONTE, S. T. TITCOMB, and R. H. COTTON, Continental Baking Company, Rye, New York

Histochemical Characterization of Wheat and Wheat Products. VI. Sulfhydryl Groups: Their Determination in Wheat Flour
Y. POMERANZ and J. A. SHELLENBERGER, Kansas State University, Manhattan

Current Status of Knowledge on Wheat Flour Proteins
F. R. SENTI and R. J. DIMLER, Northern Regional Research Laboratory, Peoria, Illinois

The Phospholipids of Wheat Flour
D. F. HOUSTON and D. K. MECHAM, Western Regional Research Laboratory, Albany, California

Hydration Characteristics of Flour Doughs in Dilute Acid
D. K. MECHAM, H. A. SOKOL, and J. W. PENCE, Western Regional Research Laboratory, Albany, California

The Role of Some Flour Components and Related Substances in the Bromate Reaction in Dough
W. BUSHUK and I. HLYNKA, Grain Research Laboratory, Winnipeg, Canada

Rheological and Thermal Studies of Soft Wheat Flour Doughs
W. T. YAMAZAKI, Federal Soft Wheat Quality Laboratory, Wooster, Ohio

Basic Scientific Facts Relative to the Reproducibility in Farinography
FRITZ ZUCKER and C. W. BRABENDER, C. W. Brabender Instruments, Inc., South Hackensack, New Jersey

The Effect of Starting Temperatures on Amylograms
W. C. SHUEY, General Mills, Inc., Minneapolis, Minnesota

The Application of Starch-gel Electrophoresis to the Water-soluble Proteins of Wheat Flour
DONALD C. ABBOTT, BYRON S. MILLER, and JOHN A. JOHNSON, Oklahoma State University, Stillwater, and Kansas State University, Manhattan

Preparation and Properties of Sulfated Wheat Flour
H. E. SMITH, C. R. RUSSELL, and C. E. RIST, Northern Regional Research Laboratory, Peoria, Illinois

Deamidated Gluten — Preparation and Properties
O. E. WEISLOGEL, C. R. RUSSELL, and C. E. RIST, Northern Regional Research Laboratory, Peoria, Illinois

Laboratory Techniques and Gadgets

Recent Developments in the Kjeldahl Test as to Procedure and Time Saving Techniques
C. D. NEILL, Board of Trade Laboratory, Enid, Oklahoma

A Comparison of Flour Particle Size Distribution Obtained by a Sedimentation Process and by Electrolytic Resistivity Changes
E. J. JASKA, Research and Development Laboratories, The Pillsbury Company, Minneapolis

Photomicrography Techniques
R. E. ANDERSON, Archer-Daniels-Midland Co., Minneapolis

A Quantitative Measurement of the Squeeze Test for Bread Freshness
G. HILL and G. DALBY, Ward Baking Company, New York

Filtering Devices for Crude Fiber
K. E. HOLT, Archer-Daniels-Midland Co., Minneapolis

A Micro, Water-Jacketed Bowl for the Amylograph
R. M. SANDSTEDT and R. C. ABBOTT, Department of Biochemistry and Nutrition, University of Nebraska, Lincoln

MacMichael Viscosity — Simplified Preparation of Suspensions
K. A. GILLIS and G. W. PEARCY, The Pillsbury Company, Minneapolis

Dilatometry — Rapid Method for Finding Sample Size
R. L. DOWDLE, Humko Products, Memphis

Multi-Small-Diameter Rolls in Experimental Milling
C. W. BRABENDER, C. W. Brabender Instruments, Inc., South Hackensack, New Jersey

Chemistry and Technology of Grain

Corn Dry Milling: Vacuum Drastically Reduces Temper Time
O. L. BREKKE, L. A. WEINECKE and E. L. GRIFFIN, JR., Northern Regional Research Laboratory, Peoria

Corn Dry Milling: Influence of Feed Rate on Beall Degerminator Performance
O. L. BREKKE, L. A. WEINECKE, and E. L. GRIFFIN, JR., Northern Regional Research Laboratory, Peoria

A Rapid Light Absorption Test for Determining Damage in Yellow Corn
ROBERT M. JOHNSON, Market Quality Research Division, U.S. Department Agriculture, Beltsville, Maryland

Variation in Color and Size in the Hilar Layer in White Corn
M. J. WOLF, DOROTHY BRADBURY, and R. J. DIMLER, Northern Regional Research Laboratory, Peoria

On Glutamic Acid Decarboxylase Activity of Stored Wheat and Corn
PEKKA LINKO, Kansas State University, Manhattan

Quality Requirements and Problems Encountered in Foreign Marketing of Wheat
EDWARD F. SEEBORG, Grain and Feed Division, Foreign Agriculture Service, U.S.D.A., Washington, D.C.

The Biuret Test as Applied to the Estimation of Wheat Protein
A. J. PINCKNEY, U.S. Department of Agriculture, Beltsville, Maryland

Lipids

Some Characteristics of Yolk Affecting Cake Doughnut Performance
MAURA L. BEAN, HELEN L. HANSON, T. F. SUGIHARA, and LEO KLINE, Western Regional Research Laboratory, Albany, California

The User Looks at Bulk Lard Quality
WILLIAM DRAKERT, Continental Baking Company, Rye, New York

Antioxidant Losses From Stabilized Cereal Products
FRANK D. HANNAH, JR., Eastman Chemical Products, Inc., Kingsport, Tennessee

The Synergistic Effect of Calcium Propionate and Sorbic Acid in Inhibiting Mold Growth on Partially Baked Rolls
H. F. ZIEGLER, JR., and R. D. SEELEY, Anheuser-Busch, Inc., St. Louis, Missouri

The Effect of Heat on Batters. IV. Shortening Crystallization
CAROLYN MORROW and R. C. A. BRADSHAW, The Quaker Oats Company, Barrington, Illinois

The Effect of Fatty Acid Composition on the Performance of Lactylated Monoglycerides in Cake Mixes
IRA A. MACDONALD and ALAN S. GEISLER, Atlas Powder Company, Wilmington, Delaware

Separation of the Lipase and Esterase Activities of Wheat Germ
C. E. STAUFFER, R. L. GLASS, and W. F. GEDDES, University of Minnesota, St. Paul, Minnesota

New Processes and Problems Arising from

Particle Sizing in the Milling Industry

By Kenneth T. Whitby
Department of Mechanical Engineering
University of Minnesota, Minneapolis, Minnesota

FOR A LONG time, the flour miller has been making particles, the cereal chemist studying them, and the baker using them. Only recently, however, have flours become so fine that the usual sieving method of size analysis has become totally inadequate. Thus the renewed interest in recent years in the subject of particle size analysis.

The milling process may be viewed as in Fig. 1. The basic problem is to take a variable heterogeneous raw material (endosperm, germ, and bran) having variable properties, separate the endosperm from the undesired materials, and process it into products having specified and narrow ranges of properties. Several important steps, such as cleaning, grinding, sieving, and air classification, involve particle size as a basic particle property important to the process. Thus the miller is interested in particle sizing because several of his important machines process particles according to size.

The recent paper by Sullivan, Engebretson, and Anderson (4) shows that there is a relationship between a number of important flour properties and particle size. While the cereal chemist is primarily interested in the chemical characteristics of the flour, he must also be interested in particle size, since the process which he directs is done primarily by particle sizing. Thus the cereal chemist's interest is for the same reason as the miller's — that the processing is according to size.

One reason for the resurgence of interest in sub-sieve particle-size measurement in recent years is the development of flour processing which utilizes impact grinding and air classification. Since these new processes are capable of producing flours having particle sizes much finer than was considered necessary 10 or 20 years ago, sub-sieve particle size has become very important in research and control of such processes.

This paper will be particularly concerned with nomenclature and the basic concepts necessary to understand and utilize particle-size distribution data. Some illustrative examples will show various concrete applications from the flour milling industry for such data.

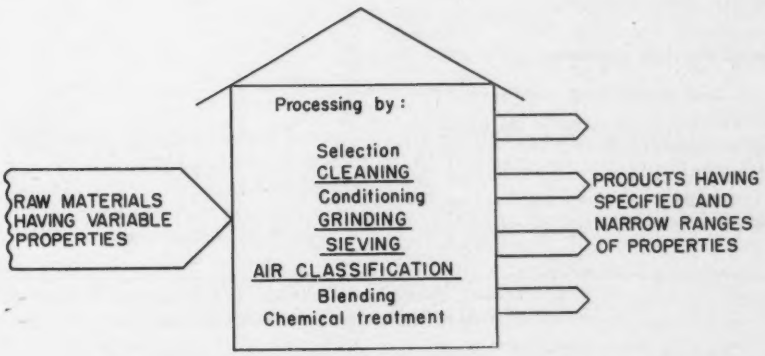


Fig. 1. The flour milling process. Processes involving particle size are underlined.

Particle-Sizing Methods

Most particle-sizing methods do not measure size directly, but measure some property from which a simple characteristic dimension is calculated, for the purpose of describing a three-dimensional object. There are, of course, a number of different ways in which this can be done; they may be classified as geometric, fluid drag, and miscellaneous methods. Detailed discussion of individual methods can be found in several books (2,3,4).

Best-known of geometric methods are microscope and sieve sizing. No one who has not himself done some microscope particle sizing can properly appreciate the limitations of this method: does one measure the length, the width, a diameter based on the area, or some combination? These problems and many more must be considered if data are to be sufficiently accurate to be useful.

During sieving, particles are rattled around on a sieve until they fall through an irregular-shaped opening. The relationship of the nominal size of the mesh opening to the dimensions of the particle depends on numerous variables besides particle size (5).

Dozens of particle-size distribution measurement methods, utilizing the fact that the fluid drag of a particle is related to its size, have been invented. If the fluid is stationary and the particles move they are called sedimentation methods; if the fluid moves and the particle is nominally stationary they are called elutriation methods. The various sedimentation methods vary principally in how they sense

the sedimentation as a function of time. Among the more important sensing methods are determination of concentration from pipetted samples, density measurement by hydrometer or sediment balance, height of sediment in a capillary, and measurement of turbidity.

Elutriation methods, whether gravity or centrifuge, usually measure the amount of the separated fractions after separation at a given particle size setting.

Among the important miscellaneous methods is one that measures the change in resistance of an electrolyte as particles traverse a short tube.

In view of the diversity of principles comprised by the methods mentioned above, it is not surprising that the "size" numbers obtained do not agree exactly. By proper calibration it is possible to make various size analysis methods to agree within a few percent, but lack of such agreement should not be reason to consider any one method fundamentally more accurate than another. Reproducibility, convenience, cost, etc., are usually more important; for who is to say which one-dimensional representation of a three-dimensional particle is fundamentally more accurate than another?

Small-Particle Statistics

A few basic facts might be reviewed concerning data on particle size analysis. First, the particle technologist is rarely interested in the individual particle as such. Flour milling processes make particles in uncountable numbers and the baker uses them in the same way. Therefore, the particle technologist is much more interested in the average characteristic of particle systems than he is in any individual particle. This means he must deal with the statistics of very large numbers of particles.

Basically, a size distribution represents a very large number of data points which in turn represent on a relative scale the properties of the various particles. This is illustrated in Table I. Suppose that the data of columns 2 and 3 were obtained from a microscope count. Column 2 indicates the size of each reticule number and column 3 represents the number of particles of each size that were counted. If the total number of particles is divided into the number in each size range, the data in column 4 are obtained. If the data of column 4 are divided by the width of each size category, the data of column 6 are obtained. If these data are then plotted as in Fig. 2 (a), we have what is called a frequency or derivative plot of the particle size weighted by number. Further, if the various particle sizes are summed as in column 5 and reduced to percentages and plotted as in Fig. 3 (a), we obtain what is known as the cumulative or integral size distribution weighted by number.

In the example just given, the quantity which has been summed has been number of particles and this has been plotted against size as the distributed variable. We can also sum area and volume. Furthermore, the weightings by number, area, or volume can be plotted against particle area or particle volume as well as particle size. This is illustrated in the remaining columns of Table I and in the resulting distributions plotted in Figs. 2 and 3. The same particle-size data can be represented by three weightings and three different powers of the variables known as

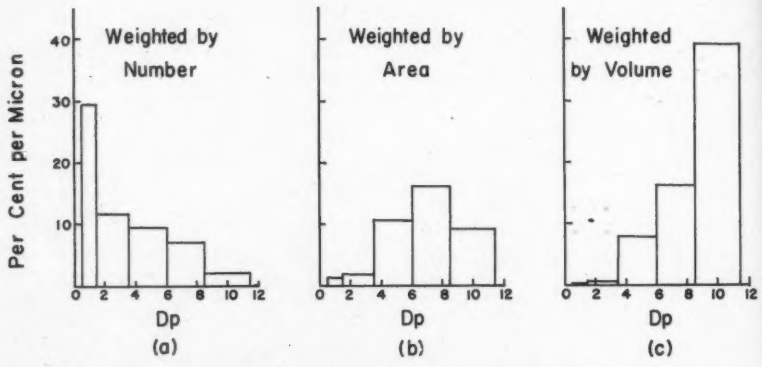


Fig. 2. The different weightings of a size distribution shown on a size-frequency plot.

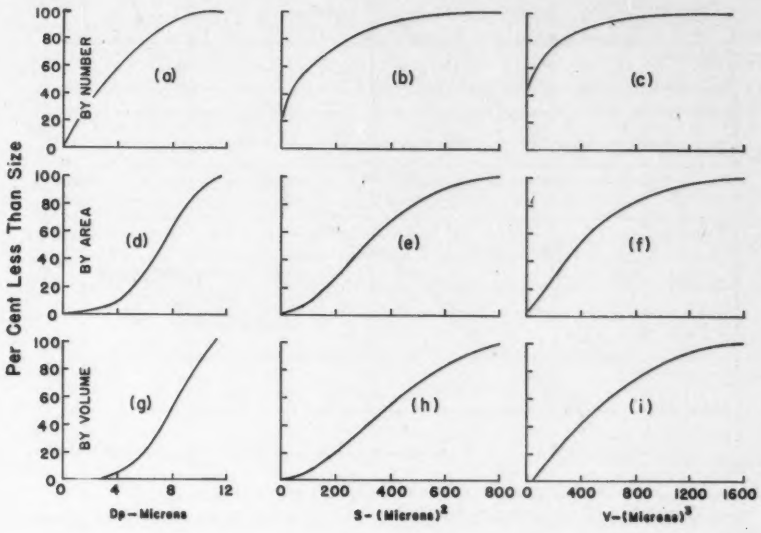
Table I. Example Calculation of the Various Weightings and Moments of a Particle Size Distribution from Count Particle Size Data

D_p[a]	D_{p1}[b]	n_1	n_1/N	$\Sigma\frac{n_1}{N}$	%	D_p^2	D_{p1}^2	S_1[c]	n_1S_1	$\frac{n_1S_1}{S}$	$\frac{\Sigma n_1S_1}{S}$	%	D_p^3	D_{p1}^3	n_1V_1[d]	$\frac{n_1V_1}{N}$	$\frac{\Sigma n_1V_1}{V}$	%
μ	μ		%	%	μ	μ^2	μ^2	μ^2		%	%	μ^2	μ^3	μ^3		%	%	μ^3
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
0.5				0		0.25					0		0.125					
	1	5	29.5		29.5		1	6	30	1.36		1.36		1	5	0.20		0.20
1.5				29.5		2.25					1.36		3.38				0.20	
	2	4	23.5		11.8		4	24	96	4.35		2.18		8	32	1.25		0.63
3.5				53.0		12.3					5.71		42.8				1.44	
	5	4	23.5		9.4		25	150	600	27.2		10.9		125	500	19.5		7.8
6				76.5		36.0					32.9		216				20.9	
	7	3	17.6		7.0		49	249	882	39.9		15.9		343	1029	40.0		16.0
8.5				94.1		72.3					72.8		615				61.1	
	10	1	5.9		2.0		100	600	600	27.2		9.1		1000	1000	38.9		38.9
11.5				100.0		133.0					100.0		1525				100.0	

[a] Interval boundary.
[b] Interval midpoint.
[c] $S_1 = a_v D_{p1}^2$, for cube $a_v = 6$.
[d] $V_1 = a_v D_{p1}^3$, for cube $a_v = 1$.
$N = 17$; $S = 2208$; $V = 2566$.

the moments (Fig. 3). Thus there are nine different ways of representing the same data, and each of these nine distributions can be represented as either a frequency or a cumulative plot. As will be pointed out later, the various methods of particle size analysis yield different moments and weightings. This has been a source of considerable confusion in particle technology literature.

Fig. 3. The three different weightings and three different moments shown as cumulative distribution plots.



Reduction of Data

Though it is often necessary to consider the size distribution data as a whole, in many cases it is desirable to characterize the particle size distribution, which essentially represents an infinity of data points, by as few parameters as possible. The three measures usually used to reduce size distribution data are (a) some measure of central tendency such as a mean, (b) some measure of spread such as the standard deviation or geometric standard deviation, and occasionally (c) a measure of symmetry (skewness).

Several different measures of central tendency are in common use. Perhaps the most common is the use of the median, which is the particle size area or volume at which the cumulative size distribution curve crosses the 50% point. The popularity of the median is due principally to its ease of determination. Other methods or measures of central tendency in common use are the arithmetic mean, the geometric mean, and the harmonic mean. Since the central tendency of each of the nine size distributions can be characterized by 1) the mode, 2) the arithmetic mean, 3) the geometric mean, or 4) the harmonic mean, there are at least 36 different ways of expressing the central tendency of a single particle size distribution. This fact which has generated endless confusion among particle technologists and in the literature, makes it necessary to accompany particle size data with a clear statement as to which of the weightings and moments, and which of the means, are being used.

Moments and Weightings

It was mentioned above that the various methods of particle size analysis measure different moments and weightings of the size distribution. The moments and weightings measured by some of the more common methods are shown in Table II. From this table it can be seen that particle count by microscope yields a measure of the first moment weighted by number, that sieving yields the first moment weighted by volume, and that the sedimentation methods measure the second moment weighted by volume. Ordinarily, sedimentation methods are set up in such a way that the calculations include taking a square root; thus the data are ordinarily presented as the first moment weighted by volume. It may be noted here that the Coulter counter measures the third moment weighted by number. This is a rather uncommon form of the size distribution data, and they are usually converted either to the first moment weighted by volume or to the first moment weighted by number.

Table II. Weightings and Moments Measured by the More Important Particle Size Distribution Measurement Methods

Distribution Weighting (Variable Summed)	*Distribution Moment (Power of Distributed Variable)*		
	Size — First	*Area — Second*	*Volume — Third*
By number	Microscope count	Light-scattering particle counters	Coulter Counter
By area		Turbidimetric	
By volume or weight	Sieving	Andreasen MSA-Whitby Oden methods Hydrometer Elutriation Air classifiers	

Since conversion of data from one moment and weighting to another is common and often necessary, the accuracy of such conversions should be scrutinized. In general, accuracy increases for higher moments converted to lower moments and decreases for lower moments converted to higher moments. Thus there is no loss of accuracy in converting volume (a third moment) to a first moment (size), or a second moment (area) to a first moment, as is ordinarily done in making sedimentation calculations. However, serious problems of accuracy are encountered in making conversions from one weighting to another. In general, converting weighting by number to weighting by volume involves a serious loss of accuracy at the

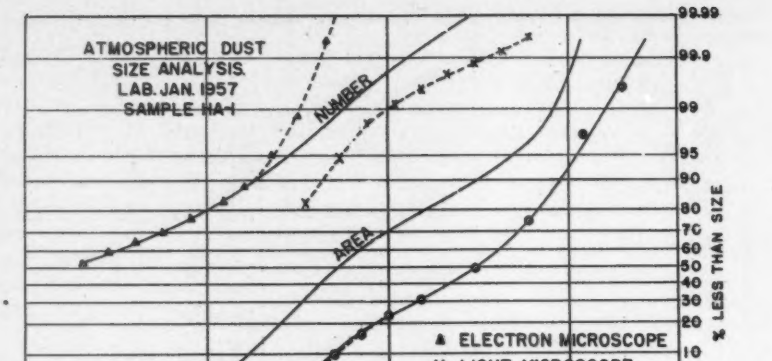


Fig. 4. Comparison of the weightings by number, area, and volume for a sample of atmospheric dust.

Fig. 5. Typical particle-size distributions of some mill products.

coarse end of the distribution, owing to the proportionately large contributions of a few large particles. Similarly, there is serious loss in accuracy at the fine end of the distribution in converting from a volume to a number weighting. Thus, converting microscope count data to weight data requires that elaborate precautions be taken to ensure the accuracy of the count on the large particles. This is the reason for multiple stage counts.

Utility of Data Presentations

What are the advantages and disadvantages, or the utility, of the various methods of presentation of size distribution data? This is not a simple question, but a few general comments are in order. One is ordinarily not very interested in the number of particles and hence the number size distribution of flour. The chemical characteristics of powders are influenced mostly by their surface area. However, the amount of material which can react is proportional to the volume or weight of particles. For this reason the particle size distributions weighted by surface or by volume are ordinarily of most interest. The principal reason for the popularity of the first moment of size distribution may be that human beings seem to have a liking for describing objects in terms of a single dimension; hence, particle size is most often used as the distributed parameter.

Figure 4 illustrates the differences between the number, area, and volume distributions of a sample of atmospheric dust. Note that the less than 0.1% by number larger than 1 μ accounts for 75% of the total weight of the particles.

Mathematical Forms

So far nothing has been said about mathematical forms which can be used to characterize particle size data and, more specifically, particle size distributions of materials of interest to the cereal chemist. Most of the flours and other intermediate products manufactured in the milling processes are not fitted well enough by the various size distribution functions to make it worth the trouble to reduce the data to the variables of the distribution function. However, certain graphical forms, based on size distribution functions, are very useful in plotting cumulative size analysis data.

Perhaps the most useful of these is the log-probability plot (see Figs. 10 and 11). The fact that many size distributions are approximately linear on this kind of plot aids in the smoothing of the data, even though the plot is not exactly linear. The log-normal plot tends to make the data at the extremes of the distribution look poor because of the expanding scales. For this reason size analysis data are often plotted on semilog paper, with particle size on the log scale. The scatter of the data on such plots appears more constant along the whole curve.

Applications of Data

Having considered particle size distributions in general, we can turn to some applications of data in the flour-milling industry, practically all of them falling under the broad heading of machinery evaluation. After the cereal chemist has determined the relationships between particle size and those chemical characteristics in which he is interested, it is up to the milling industry to design equipment which will produce the desired particle size characteristics as well as the other desired chemical characteristics. At the present time, therefore, most equipment for subsieve particle size analysis is used for research and development purposes, with only limited application for quality control.

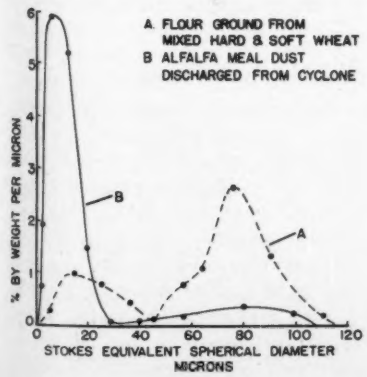
Probably everyone is familiar with the so-called protein shifting which has been accomplished by fine grinding and air classification of flour in recent years. Subsieve size analysis has played an important part in these developments. The discussion which follows is intended to illustrate some of the ways in which particle size analysis data have been used in this work.

In Fig. 5 are illustrated the particle size distributions of durum, soft wheat, hard spring wheat, buckwheat, and rice flours. Note that the particle-size distribution of soft wheat flour is considerably finer than that of the hard spring wheat. The rice flour presents a trimodal distribution—the only genuine trimodal distribution that the author has observed during years of measuring particle size distribution.

Figure 6 shows two bimodal distributions that have been observed. In A, the strong bimodal characteristic is due to the fact that the softer wheat yields a fine distribution, whereas that of the harder wheat is coarse.

The next step, beyond merely looking at particle size distributions to note their relative coarseness, their number of modes, and any other easily observed features, is to do either of two things: 1) correlate some measure of particle size derived from its distribution, with chemical characteristics as was done by Sullivan, Engebretson, and Anderson (4); or 2) use the distribution data to analyze the performance of processing machines. Since the first procedure is outside the author's field of interest, only the latter will be discussed here.

Fig. 6. A flour and a dust with strongly bimodal size distributions.



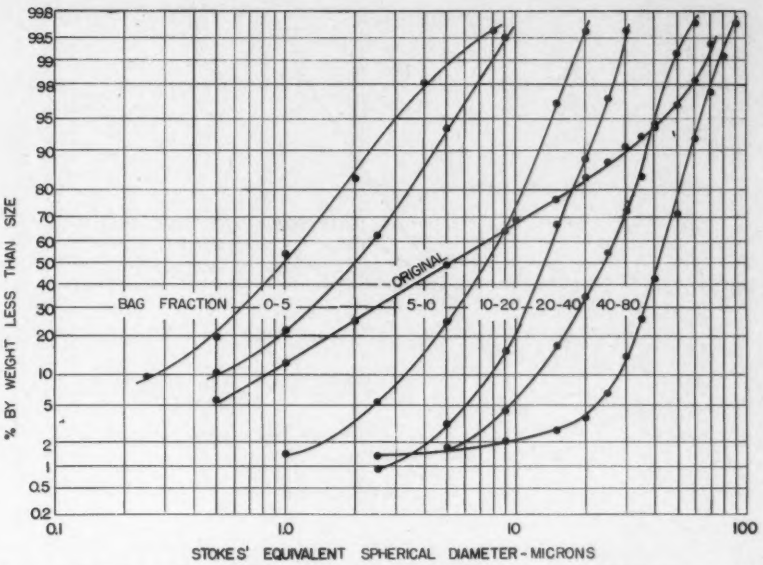
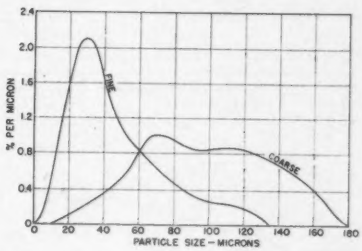


Fig. 7. Cumulative size distributions of fractions classified from fine Arizona Road Dust, a standardized air cleaner test dust.

The two types of process in which subsieve particle size analysis has been of the greatest utility are fine grinding and air classification of flours.

Fine Grinding

Analysis of the performance of grinding equipment with respect to particle size is relatively simple. Usually particle size is run on the



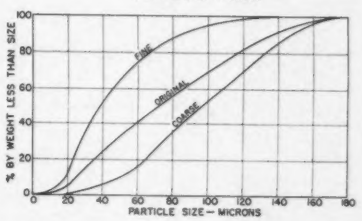
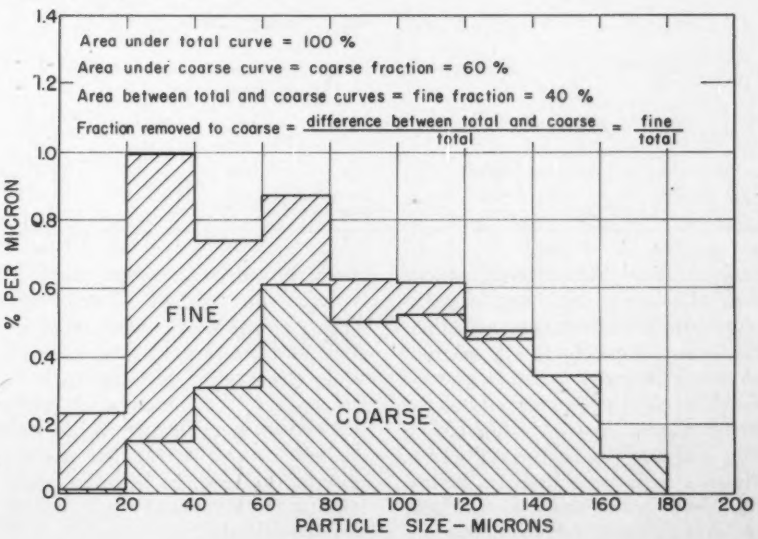


Fig. 8. Typical size distributions of original, fine, and coarse fractions air-classified from a hard wheat flour.

Fig. 9. Data of Fig. 8 plotted so that areas under frequency curves are proportional to relative amounts of fine and coarse fractions.



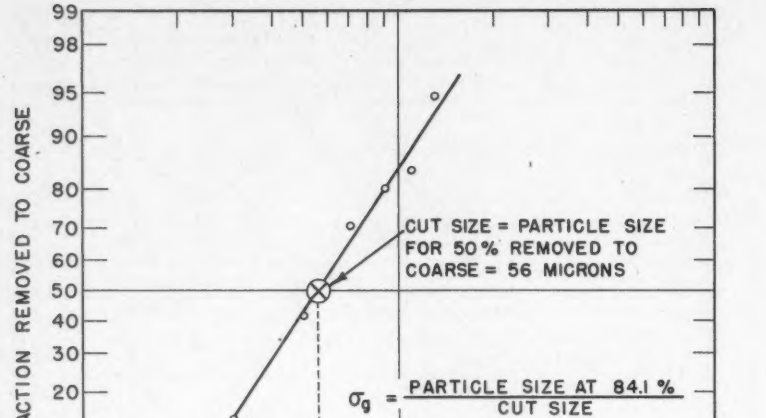


Fig. 10. Log-probability plot of classifier efficiency.

Table III. Example Calculation of a Classifier Efficiency Curve

Size μ	f_c %	F_c %	f_f %	F_f %	$f_c w_c$ %	$f_f w_f$ %	f_o %	F_o %	η %
0									
	0.33		11.0		0.2	4.4	4.6		4.3
20		0.33		11.0				4.6	
	5.0		42.2		3.0	16.9	19.9		14.1
40		5.33		53.2				24.5	
	10.3		21.5		6.2	8.6	14.8		41.9
60		15.7		74.7				39.3	
	20.3		13.0		12.2	5.2	17.4		70.2
80		36.0		87.7				56.7	
	16.7		6.3		10.0	2.5	12.5		80.1
100		52.7		93.9				69.2	
	17.3		4.8		10.4	1.9	12.3		84.7
120		70.0		98.7				81.5	
	15.0		1.3		9.0	0.5	9.5		94.7
140		85.0		100.0				91.0	
	11.5		..		6.9	..	6.9		100.0
160		96.5		....				97.9	
	3.5		..		2.1	..	2.1		....
180		100.0		....				100.0	
					60.0	40.0	100.0		

$$\eta = f_f w_f / f_o = f_f w_f / (f_f w_f + f_c w_c) = \frac{f_o - f_c w_c}{f_o}$$

$$\eta = \frac{f_o - f_c w_c}{f_f w_f + f_c w_c}$$

where f = frequency of i^{th} size;
w = mass, area, or number fraction;
$f_o = f_c w_c + f_f w_f$
η = fraction of i^{th} size removed to coarse, or efficiency of separation of coarse.

feed to the machine and, in the case of a simple grinder, size distribution measurements are then made on the product. The median or other selected particle size of the feed and the particle size of the product may then be compared to obtain a measure of the reduction. Since there is some basis for believing that work input to the material is proportional to the surface area produced, another basis of comparison is to calculate and compare the specific surface of the feed and product. In some cases the objective of fine grinding may be to reduce the material to some maximum particle size rather than to reduce the average or median size of the feed. In this case attention may be focused on a particular particle size.

Though a number of fineness moduli and other grinding indices have been proposed, none of these have any significant advantage over using the median, the particle size corresponding to a given percentile on the size distribution, or the specific surface.

Air Classification

Considerable attention has been focused in recent years on the analysis and development of air-classification equipment. Proper evaluation of this kind of machinery requires fairly sophisticated application of particle size data. Therefore a more detailed discussion of this subject will be included here.

A classifier may be looked upon as any device which will separate material into two or more fractions. This definition and the method of analysis described here can therefore be applied to sieving equipment, to air-classification equipment, and to any other piece of machinery which makes a separation according to particle size.

We might begin by looking at some particle size distributions produced by classifying devices. Figure 7 shows six fractions classified from a mineral dust called Arizona Road Dust by a Federal Classifier. These classifications were not all made at one time, but by use of repeated settings on the instrument. There is considerable overlapping of particle size and even the coarsest fractions contain quantities of quite fine particles. Thus it is apparent that classifying equipment is not perfect. Further observations from Fig. 7 are that it is difficult (a) to characterize each fraction by a single characteristic size, and (b) to characterize the setting of the classifier by what we might call the cut size.

Classifier Performance

Since most classifying equipment usually separates feed material into only two cuts at one time, let us consider how we might analyze the performance of the two-cut classifier. In Fig. 8, the upper part illustrates typical particle size distribution data for the original and fine and coarse fractions from a laboratory-type classifier; the lower part shows the size dis-

tribution of the fine and coarse fractions on a frequency plot. Though it is obvious from Fig. 8 that the fine fraction is finer than the coarse fraction and original fraction, it is difficult to say much more about the data.

Suppose, however, that we plot the data as shown in Fig. 9, in such a manner that the area under the coarse curve is proportional to the weight of particles in the coarse fraction, and the area between the coarse and total curve is proportional to the weight of the fine fraction. From this figure it can be seen that the classifier has done a better job of separating the coarse particles from the original material between 120 and 140 μ than it did between, say, 20 and 30 μ. If we were to define as an efficiency the goodness of the classifier as to its ability to separate the coarse particles from the original material, then the efficiency of the classifier becomes the ratio of the amount of the coarse fraction within a given size range to the original amount within this size range. In this manner an efficiency corresponding to each particle size range can be computed and plotted as in Fig. 10: here the efficiencies are plotted on a log-probability plot. It can be shown from mathematical statistics, and with certain assumptions regarding the mechanisms of classification, that such an efficiency curve should be approximately a straight line on this log-probability plot. Such a plot provides us with measures of two important classifier characteristics: 1) definition of a cut size, which is independent of the relative amounts of the fine and coarse fraction and is independent of the initial size distribution of the feed material; and 2) sharpness of classification. The better the classifier, the steeper the plot on the log-probability paper. If the geometric standard deviation defined as shown in the figure is used as a measure of the sharpness of classification, then the better the classifier, the smaller will be the geometric standard deviation.

In Fig. 11 are shown some typical separation efficiency curves for several different classifying devices. One of the advantages of this

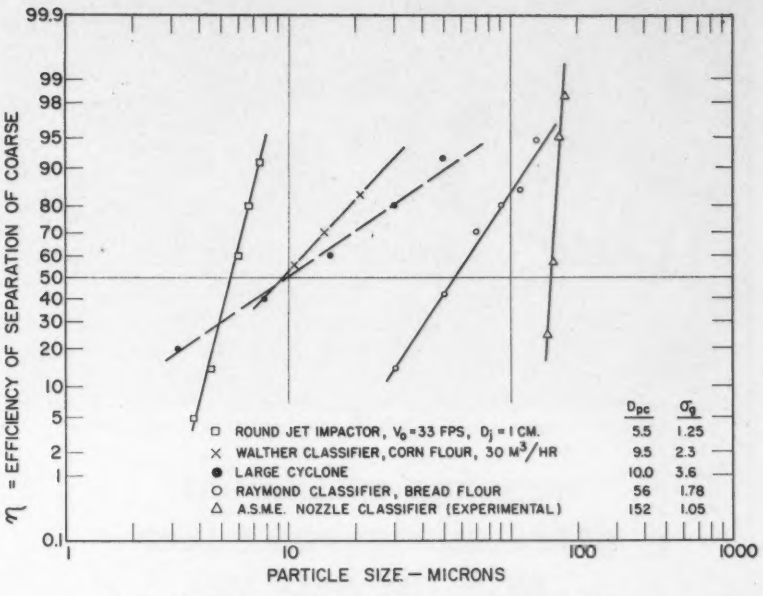


Fig. 11. Classifier efficiency characteristics of several classifying devices.

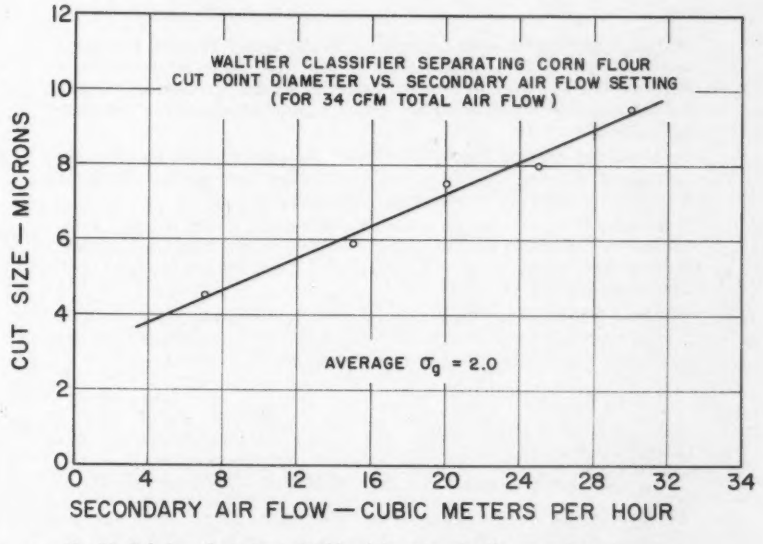


Fig. 12. Relation of cut size to Walther laboratory classifier secondary air setting.

scheme of classifier rating is that it can be applied to such widely different devices as jet impactors, air classifiers, and even dust collectors such as the cyclone. From Fig. 11 it will be seen that the dust classification devices have sigma g's of about 2 and that these range up to as high as 3.6 for a large cyclone. Most commercial air classifiers used in the milling industry probably have sigma g's between 1.6 and 2. An example calculation of such a curve is shown in Table II.

Using this evaluation scheme, the cut-size calibration of the Walther classifier in the particle laboratory has been evaluated (Fig. 12). This is for the unmodified classifier, and the range of cut sizes obtainable is rather limited. It is possible to extend the cut size to larger sizes by increasing the secondary air flow, but this necessitates installing additional flow-metering equipment and other modifications. Although the relationship of the cut size to the secondary air flow should theoretically be independent of the nature of the material being separated, this is not necessarily true in the case of material such as corn flour. However, this scheme of clas-

sifier evaluation is relatively independent of the original particle size distribution and the nature of the material, and is therefore quite useful as a measure of classifier characteristics.

The definition of classifier efficiency used here should not be confused with the ratio of the fine to coarse from the classifier. The latter has sometimes been called classifier efficiency.

Data on particle size distribution should not be viewed by the cereal chemist as an end in themselves, but as another physical measurement, which if properly interpreted can provide a basis for valuable correlations and insights into the operation of important milling processes. Subsieve particle sizing is here to stay, but it is up to those who are interested to evaluate the usefulness of the various methods and to disseminate basic techniques for interpreting and utilizing size-analysis data.

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DALLAS, THE CITY affectionately known as "Big D," has grown huge and prosperous but has never lost the Southwest hospitality that makes it a favorite with visitors. Assembling there for the AACC's 46th annual meeting, members, wives, and guests who know Dallas will make a joyful return, and you who see it for the first time are sure to be drawn into the net of its charm.

Program in Preparation

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AACC conventioneers will find in Dallas a booming city, but no raw boom town — the largest urban area in the southern half of the United States east of Los Angeles. The city population — some 700,000 — is more than half again as many as the 1950 census figures.

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A great factor in gaining for Dallas that proud name, Big D, has been the oil industry. The city is in the center of the mid-continent oil fields and thus is headquarters for hundreds of firms engaged in oil production, independent oil operators, drilling contractors, and allied interests. Scores of specialized oil industry services — such as dealers in oil well mud — headquarter in Dallas. Of particular importance is the concentration here of a number of world-renowned petroleum geologists and geophysicists. The large geophysical laboratories of these firms are important assets to the petroleum industry as a whole.

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A feature of Dallas not to be missed is the State Fair Grounds, open all year. Texas' State Fair, held during the first two weeks of October, is (naturally) the largest in the nation. On the same grounds can be found the Texas Hall of State, which houses the extensive collection of the Dallas Historical Society; the Aquarium; the Museum of Fine Arts; the Museum of Natural History; the Health Museum; State Fair Music Hall, and the Cotton Bowl, home of the big-time college and professional football in the Southwest. The Music Hall is the Southwest's only host to the Metropolitan Opera and is the home of the Dallas Civic Opera and the Dallas Symphony Orchestra.

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The Texas Hall of State, facing the beautiful Esplanade of the State Fair of Texas, is a shrine honoring the heroes of the Lone Star State. Along with the other museums on the grounds of the State Fair, it is open throughout the year.

Recreation

Outdoor interests are easy to satisfy in Dallas, too. Its parks number more than 100, having over 6,500 acres of developed recreational facilities. Swimming, boating, fishing, watching the birds and animals in the Marsalis Park Zoo are all popular pastimes.

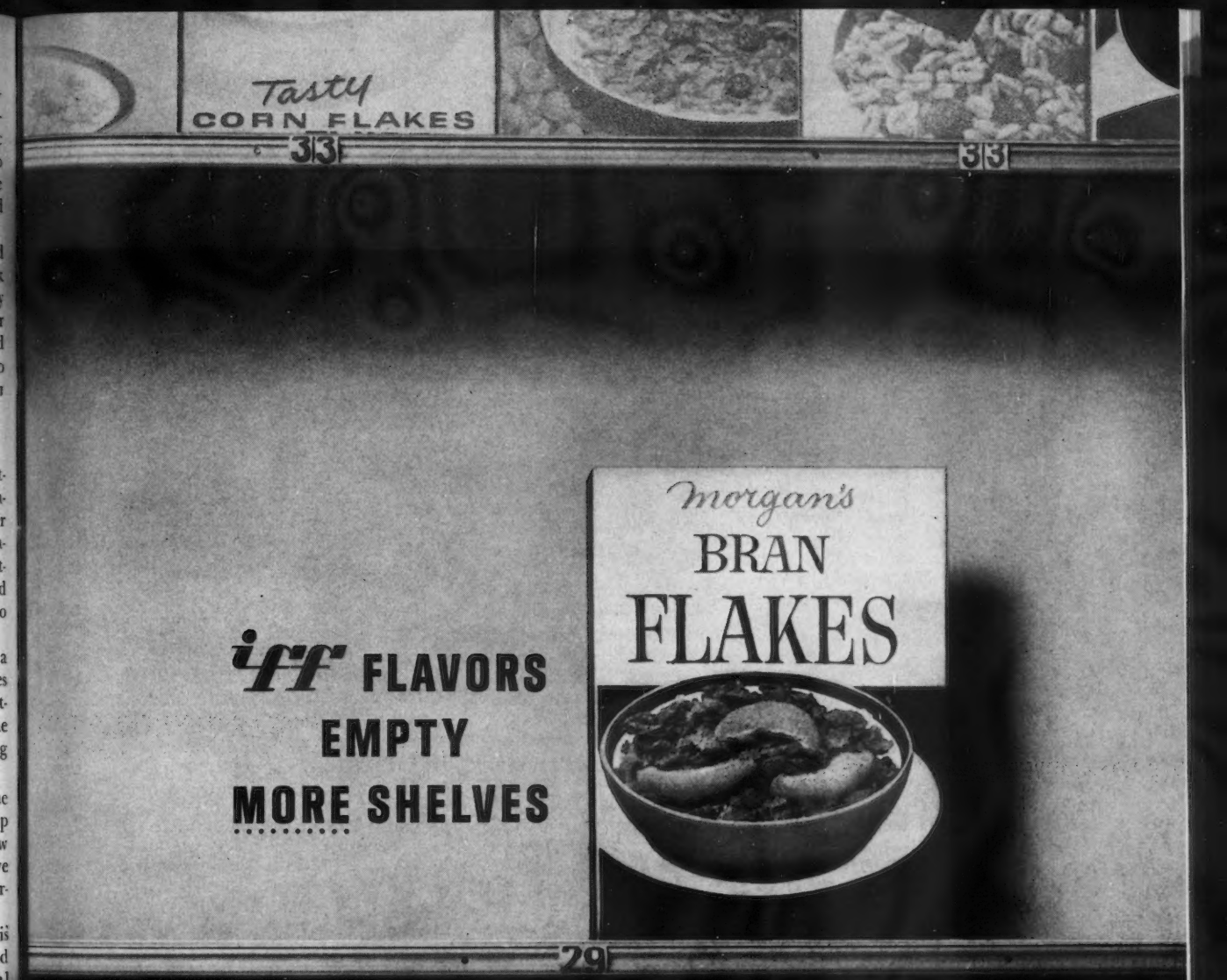
Feminine visitors find this city a fashion capital, with its fine stores that satisfy every taste and pocketbook. Downtown Dallas claims the title of Texas' largest shopping center.

Dallas is the top air center in the Southwest, ranking among the top 10 cities in the nation. A fine new terminal building at Dallas Love Field strengthens the city's leadership in air transport.

Southern Methodist University is here, well known for its law and engineering courses, theological studies, school of business administration, and pre-medical course. Its fine athletic teams and musical groups also have earned it national acclaim.

In addition to theaters, numerous nightclubs and restaurants present excellent entertainment. For your sampling and enjoyment there are Mexican, Swedish, Italian, German, Greek, Polynesian and Chinese foods. Dallas has four or five restaurants always listed among the nation's finest.

Yes, Dallas offers just about everything, but most important, it offers plenty of old-fashioned Texas hospitality. Come along and see.



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People, Products, Patter

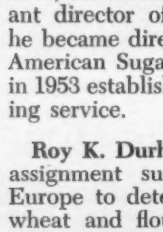
• • • People


Alesch

Edward A. Alesch promoted to technical service manager, Western Condensing Co., Division of Foremost Dairies; has been with Western since 1947 in product development, technical service, and sales capacities; associated with the dairy and baking industries for 25 years. He is active in the Dunwoody Institute and American Institute of Baking. **William L. Bermel** appointed district sales manager for North Central Zone, food products division, with office in Minneapolis. Prior to becoming associated with Western, he was with Russell-Miller Milling Co. **John R. Holstrom** named food products sales manager for Western's milk products; has worked extensively in sales for Western, previously assigned to West Coast sales staff. Will headquarter at general office, Appleton, Wisconsin.


Bermel


Holstrom

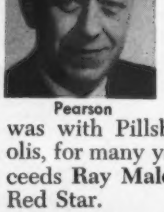

Cantor

Sidney M. Cantor appointed vp-research, DCA Food Industries Inc. He was associated with research labs of Corn Products Refining Co. from 1936 to 1947, the latter two years as assistant director of research. In 1947 he became director of research for American Sugar Refining Co., and in 1953 established his own consulting service.

Roy K. Durham begins 6-month assignment surveying western Europe to determine the kinds of wheat and flour needed by flour millers and bakers there. Mrs. Durham accompanies him.


Gaylord

Ralph E. Gaylord joins Red Star Yeast & Products Co. as vp-sales, yeast division; will direct sales and distribution of all bakery, grocery, and industrial products; formerly long associated with General Mills, most recently as director of bakery relations. **Ray H. Gohde** promoted to assistant manager for bakery yeast sales in South Central District Office, Dallas, Texas; from marketing department in Red Star's home office; has guided its bakery technical services for some years. **Vernon T. E. Pearson** joins Red Star as manager of bakery sales, Central District, to headquarter in Chicago; was with Pillsbury Co., Minneapolis, for many years until 1958. Succeeds **Ray Maloney,** resigned from Red Star.


Pearson

Kenneth A. Gilles becomes chairman, cereal technology department, North Dakota State University; from project leader, fundamental food research, General Mills at Minneapolis.

Ernest Guenther, vp and technical director, Fritzsche Bros., Inc., was guest lecturer at December 7th meeting, St. Joseph Valley Section, American Chemical Society, held at Notre Dame University.

Byron Hummel appointed chemist for Dover Milling Co., Dover, Ohio, succeeding A. R. McVey, retired.

Donald L. Robach joins chemical division of Merck & Co., Inc., as meat products technologist in food section of product development; will specialize in applied research and technical service for the meat industry.

August Kochs, 89, founder of Victor Chemical Works and vice-chairman of the board at Stauffer Chemical, died Nov. 21 in Chicago. He was born in Germany and had lived in this country since the 1890's. He began his career as a bookkeeper with his father-in-law's brokerage firm. The firm ran a baking-powder factory on the side; it was losing money and technical aid was needed. Mr. Kochs, who had studied chemistry and taken a degree from the Institute of Technology in Cassel, Germany, improved the product and put the factory on a paying basis. In 1902 it became Victor Chemical Works. The company is now merged with Stauffer Chemical. Mr. Kochs continued active in business until death.

William F. Schroeder promoted to vp, HumKo Products, on 20th anniversary of service with HumKo; also honored at luncheon January 9 in observance of both events.

Martin Wise takes charge of new wheat quality laboratory, University of Idaho; from head of research and special projects for Centennial Mills, Inc.

• • • Products

New volumetric feeder. The Merchen Volumetric feeder, just added to its line by Wallace & Tiernan Inc., measures all free-flowing powdered, granular, or lumpy solids by volume, and has a maximum capacity of 3,600 cu. ft. per hour. It is the only volumetric feeder with belt-and-feed-gate design. Models are available with 9-in or 18-in belts. Either size can be converted into a gravimetric feeder by adding weighing components. An optional off-feed switch stops the feeder or actuates an alarm when feed falls below a selected rate. Illustrated 4-page catalog and further information available from Wallace & Tiernan Inc., 25 Main St., Belleville, N.J.

• • • Patter

Laboratory purchase. Doty Laboratories of Omaha, Nebraska, purchased the Special Laboratory of

the Omaha Grain Exchange, placing E. J. Rosse in charge of its combined operations. Doty now offers complete analytical service to the feed, grain, flour, baking, and fertilizer industries in both the Omaha and Kansas City laboratories.

• • •

Givaudan honors employees. Givaudan-Delawanna, Inc., entertained 325 employees at its annual Christmas party, and presented watches to five new 25-year veterans, shown in the photo with com-

pany officers. Left to right: Max Luthy, vp; Michael Dombroski, Adam Turow; Ernest Durrer, president; Charles Perra, Andrew Csupecz, and Louis Balas. Mr. Durrer and Dr. Luthy addressed the gathering, and greetings were presented on behalf of the firm by Xavier Givaudan, grandson of one of the founders. A steak dinner, music and dancing were the company's treat.

• • •

Enrichment—"Quiet Miracle." Leading industries associated with cereal product enrichment have begun a year-long campaign, commemorating the 20th anniversary of the enrichment program's launching in 1941 and emphasizing its contribution to public health. Sponsors include bakers, flour millers, wheat growers, corn and rice millers, and macaroni manufacturers, who believe that much still needs to be done to impress on the general public the importance of enrichment in building general health. Emphasis will be on how the "quiet miracle" of enrichment has resulted in better nutrition for everyone. The American Bakers Association will cooperate with state and regional groups, presenting leading nutritional authorities as speakers who will discuss better health today and point out how 20 years of enrichment has been a potent contributing factor.

• • •

Buhler consolidation. Buhler Mill Enginering Co. of Minneapolis and Buhler Bros., Inc., Englewood, N.J., have joined to form The Buhler Corporation, with headquarters at Minneapolis. All contracts and obligations of the two former companies were assumed by the new one; all pending offers or projects are to be continued and the same technical personnel is in charge.

• • •

Conference on wheat quality. Results of baking tests of hard red spring wheat breeding lines grown on a farm scale in 1960 were reviewed at a meeting of the Crop Quality Council held in Minneapolis on December 20. Seventy were present—representatives of Upper Midwest agricultural experiment stations, the USDA, the Canada Department of Agriculture, and the milling industry. Donald G. Fletcher, executive secretary of the Council, was in charge. For the tests, 41 samples were grown at six locations in Minnesota, North and South Dakota, and Montana.

Betty Sullivan, Russell-Miller-King Midas Mills, reviewed the quality of spring, durum, and winter wheats, and E. R. Ausemus, USDA Improvement Leader for hard red spring, summarized the production situation this year.

The increased winter wheat acreage in Montana and South Dakota was discussed by Max Hager, Montana Flour Mills; F. Harry McNeal, USDA Improvement Leader for western wheat; and V. A. Dirks, South Dakota. Winter wheat breeding lines will be included in 1961 tests from plantings made earlier in Montana, South Dakota, and Minnesota.

Summaries of the baking results were given by E. J. Stone, International Milling; R. E. McCormick, Bay State Milling; W. L. Rainey, Commander-Larabee; and Grant Astleford, Russell-Miller-King Midas. A. B. Ward, the Pillsbury Co., reported on results of studies on milling characteristics.

The new durum varieties, Wells and Lakota, were discussed by Kenneth L. Lebsock, USDA durum breeder; L. D. Sibbitt, North Dakota; and by grain procurement personnel of several milling firms.

Speaking at luncheon, L. P. Reitz, head of wheat investigations, Crops Research Division, USDA, reported on current research programs. P. Norman Ness of International Milling stressed the need for high-quality varieties by producers and processors.

Discussions included the agronomic, disease, milling, and baking characteristics of breeding lines in the tests. Three wheats were considered acceptable from a milling and baking standpoint. Information on recommended varieties will be made available, Mr. Fletcher states, through agricultural experiment stations and extension services in the area.

William Findlay Geddes

Scientist

Teacher

and Friend

1896 - 1961

THE AMERICAN ASSOCIATION of Cereal Chemists has suffered a heavy loss by the death of William Findlay Geddes which occurred in Mexico City on the seventh of January.

Geddes had been the Editor-in-Chief of CEREAL CHEMISTRY since 1943, and for seven years before that, one of its Associate Editors. He was elected Vice-President of the Association in 1937 and became President the following year. Besides serving the Association with distinction in these capacities he also gave much of his time and energy to the work of its various committees. Thus, over a period of many years, Geddes was one of the guiding spirits of the AACC – contributing to its work and progress, helping to increase its usefulness to its members, and adding to the luster of its reputation in the fields of pure and applied science. It would be difficult indeed to exaggerate the debt we owe him.

By Geddes' death the science of cereal chemistry lost one of its most widely known and most distinguished figures.

He took his early training at the Ontario Agricultural College, obtaining a B.S.A. degree from the University of Toronto in 1918. His post-graduate work was done, first under Professor Lash Miller at the University of Toronto, where he was granted an M.A. in 1925; and then under Professor C. H. Bailey at the University of Minnesota, where he received his M.S. in 1928 and Ph.D. in 1929.

Early Career in Canada

Most of Geddes' life was spent in academic work. From 1919 to 1933 he taught, as Assistant Professor and later as Head of the Department of Agricultural Chemistry, at the University of Manitoba. It was here that he first became known as a gifted teacher and also as an able and most industrious research worker. He encouraged his students by example as well as by precept. He did not simply teach a course; he infected his students with his own unbounded enthusiasm for study and for the search for scientific truth. They, in turn, thought the world of him. He was their friend as well as their teacher. They never forgot him, nor he them.

In 1933 Geddes entered the service of the Canadian Government as Chemist-in-Charge of the Dominion Grain Research Laboratory in Winnipeg. Here he rapidly extended the facilities of the laboratory, enlarged its program of research, and built the firm foundations on which its reputation, as one of the world's outstanding cereal research laboratories, now rests. His position also afforded him opportunities for travel and he was able to make two extensive tours of Europe to study grain-handling procedures, and milling and baking practices. During these visits he established personal contacts with many European chemists, which led to lifelong friendships and some productive collaboration.

The Minnesota Years Begin

Late in 1938 he moved to the University of Minnesota to become Professor of Agricultural Biochemistry. From 1944 until his death he was Head of his Department there. To this great school, made famous for teaching and research in biochemistry by R. A. Gortner, and in cereal chemistry in particular by C. H. Bailey, had come graduate stu-

dents of many nationalities. They continued to come, for Geddes maintained the tradition established by his predecessors for sound teaching and for the most rigorous standards in any research which was undertaken. The result is that many of those who are today teaching cereal science in other universities, or who hold responsible positions in government and industrial laboratories engaged in the broad field of agricultural biochemistry, once studied under Gortner, Bailey, or Geddes.

Contacts Abroad

To keep in touch with current work in other parts of the United States, in Canada and in Europe, Geddes continued to do a considerable amount of traveling. Many workers also came to Minnesota to see him. As late as last September he was in Scotland to participate in a symposium on food technology at the Royal College of Science and Technology in Glasgow. It was typical of him that although far from well at the time, he not only gave his own lectures but, against the persuasion of his friends, insisted on attending those given by others. Those who knew him will not need to be told that he also took a full set of notes of what the other speakers said.

From such meetings, wherever they were held, as from personal discussions and correspondence, Geddes seemed to derive perpetual refreshment and mental stimulation. He was always eager to learn and what he learned was held by a tenacious memory and collated and used as elements in the synthesis of his own ideas.

Collateral Affiliations

Enough has been said to make it abundantly clear that Geddes dwelt in no ivory tower. On the contrary, he liked the busy world and took full advantage of the modern group-meeting system for the rapid communication of scientific and technical knowledge. He took an active part in the proceedings of a number of such groups. They included among several others besides the AACC, the Institute of Food Technologists, the American Chemical Society, the Association of Official Agricultural Chemists, and the American Oil Chemists' Society. As an authority in his field he was appointed to committees of the National Research Council, and to the Advisory Board for Quartermaster Research and Development. Wherever his expert knowledge was sought, it was freely given.

A Tribute

Professor W. F. Geddes had a large number of friends in the United Kingdom, many of whom I contacted immediately on receiving the cable announcing the sad news of his death. This note is written at the request of Dr. Moran, Dr. Coppock, Dr. Amos, Mr. Butterworth, and many others, so that his friends in U.S.A., Canada, and elsewhere may know of the high esteem in which Bill Geddes was held in this country, not only as one of the foremost cereal chemists in the world but also as a lovable person. We shall all miss him greatly, especially those who have known him so long, as for example when he was working in Winnipeg.

D. W. KENT-JONES
London, England

Publications and Honors

Geddes published his first paper in 1919 and soon afterwards there began an almost steady flow of scientific and technical papers bearing his name. It has continued ever since. In total they number about two hundred and cover a wide range of subject matter, as may be seen from the list included in the Osborne Medal Address supplement to CEREAL CHEMISTRY, Volume XXVII, No. 6. During the last ten years he and his associates continued his grain storage studies and brought to thirty-one the number of papers published in this series alone. Other papers published within this last period dealt with such diverse topics as the sugars in wheat flour and wheat germ, the constituents of milk and soy flour which affect baking quality, thermophilic spores in wheat, lipases, protease systems in bread baking, bread staling, as well as several other subjects. There was indeed scarcely any aspect of the chemistry of cereal handling and processing which was not touched on in the original papers he published during the forty years of his professional life. He also contributed chapters to the 3rd edition of Gortner's *Outlines of Biochemistry* and to other scientific and technical books.

The outstanding honors he received in recognition of his scientific work were the Osborne Medal in 1950, and the Nicholas Appert Award (sponsored by the Institute of Food Technologists) in 1958.

His Warmth of Personality

Geddes loved his work. It was seldom far from his thoughts or his conversation, and may well have entered his dreams. He gave his time to it ungrudgingly, even gladly. If he was a slave, he was a happy one. But even Geddes could not spend every waking hour thinking and talking about his work, and in fact, he did have his own ways of finding relaxation and relief.

The human quality for which most of us will remember him was his friendliness. John Donne, in a famous passage in one of his sermons, said that no man was an island, meaning that no one is isolated from his fellows by a "salt, estranging sea." Most certainly there was no such estrangement for Geddes. He put no barriers of indifference, pride, or self-conceit between himself and others. He was invariably his natural self—warm, receptive, interested, and understanding, with a disarming manner that was faintly shy and self-deprecatory—a reflection of the humility of his spirit. He often seemed to need a friendly assurance that he could succeed in some proposed task, and when it was done he liked to be told that he had indeed succeeded. He, himself, was often dissatisfied with his work, but the dissatisfaction did not go very deep or last very long, because he was soon immersed in another undertaking.

Teacher and Friend

According to one school of modern thought, the great evil from which the contemporary world suffers is the depersonalization of the

individual – the turning of people into work-hands, instruments, things. To this disrupting "evil" Geddes contributed as little as any man could. The people with whom Geddes came in contact never became dehumanized objects to him, but always remained persons, in the full sense of the word, entitled to courtesy and respect. This made the sharing of any activity with him, whether it was travel or work or play, so pleasant an experience. You, yourself, freely consented to do whatever you did.

His delight in the company of his friends was genuine and undisguised. One of the things he liked most of all was to have them in his own home where, with Mrs. Geddes, he could treat them with unlimited kindness and hospitality. In such surroundings cereal chemistry might sometimes obtrude; but for the most part it was forgotten in light-hearted talk and laughter, with Geddes often laughing at himself. To summon up such remembrance of things past now inclines us, as Shakespeare said in one of his loveliest sonnets, to

". . . drown an eye, unus'd to flow,
For precious friends hid in death's
dateless night . . ."

Journeyings

Another of Geddes' pleasures was to travel. Early in his career he used to drive to the annual meetings of the AACC in an old second-hand Ford, with one or two others for company and to lighten the expense. When it was wet, the rain came in through the side-curtains, and splashed up through the floor-boards mixed with the clay of southern Manitoba and northern Minnesota. To save money the traveling chemists usually slept in the car. As time went on his mode of travel improved, but the annual AACC meeting remained an event to which he always eagerly looked forward.

Whatever journey he was making, he set out with the joyful anticipation of the schoolboy going away for his holidays. On new scenes he looked with delighted wonder. Everything interested him and aroused in him the urge to explore and inquire. His vision never entirely lost its youthful innocence and freshness. Later on he kept a record in color slides of his travels, using his camera with almost professional skill, and with a discerning eye for composition and other esthetic values.

His Health

Throughout his life Geddes never enjoyed robust health and from time to time suffered serious illnesses. However, he never allowed himself to become a hypochondriac. The amazing thing was that in spite of his poor health he displayed such a zest for life and was able to accomplish so much. He could only have done it by continuing to work long after most people would have given up. The winters in Minnesota became more and more difficult for him as he grew older until, during recent years, he found it necessary to escape them for a few weeks each January. It was while he and Mrs. Geddes were on their way south to seek the Mexican sunshine that his fatal illness developed.

His Family

In 1920 Geddes married May Clayton and lived in domestic happiness for over forty years. Mrs. Geddes shared in many of her husband's activities, helping him in his laboratory work in the early days of their marriage, and becoming his almost constant traveling companion when the children grew old enough to be left. At our annual meetings she became almost as familiar a figure as her husband.

There were four children – one son, Richard M.; three daughters, Molly (Mrs. W. Randall), Dorothy (Mrs. W. R. Longley), and Barbara (Mrs. D. Hegg); and twelve grandchildren.

His Notable Qualities

If we ask ourselves what were the notable characteristics which contributed to make Geddes' life so full, satisfying, and successful we might answer, briefly but not untruthfully, that as far as his professional life was concerned, they were the scope of his scientific knowledge, his insatiable curiosity, and his unflagging industry; and as far as his personal life was concerned, his love for his fellows. And perhaps it might not be altogether inappropriate to conclude by adding these words of St. John: "He who dwelleth in love dwelleth in God, and God in him."

A. W. Alcock
Winnipeg, Canada

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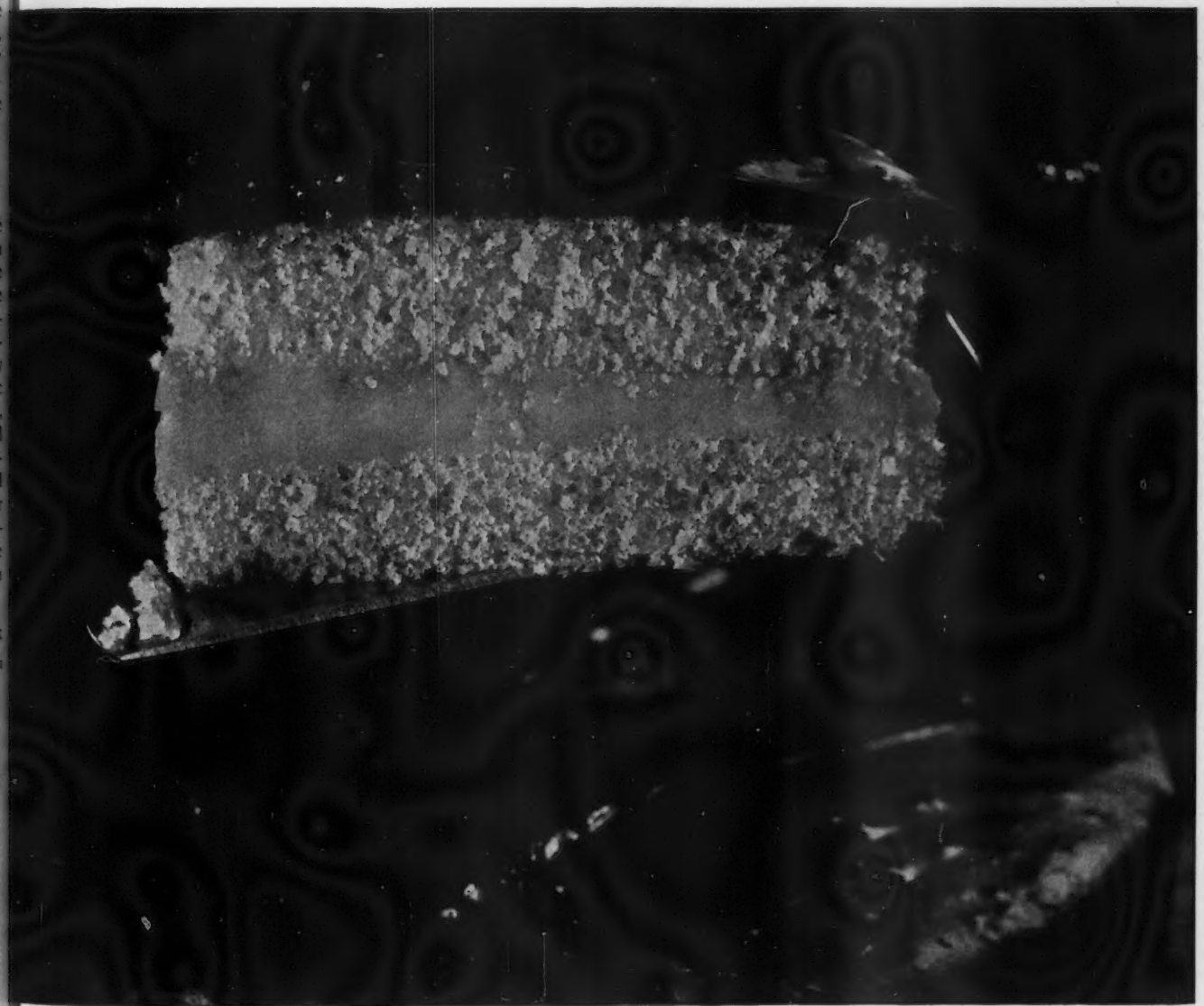

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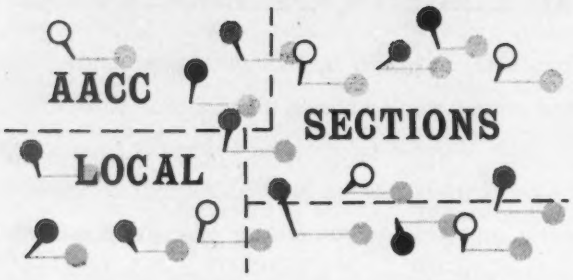

Central States Section met in St. Louis (Gatesworth Hotel) on December 2. Herbert Iveson, manager of lecithin products, Chemurgy Division of Central Soya Co., Inc., Chicago, spoke on lecithin from the standpoint of its chemistry and technology as it pertains to cereal chemistry.

A two-day symposium, January 27 and 28, at Peoria, Ill., will be devoted exclusively to flour problems.

• • • •

Kansas City Section held its annual Christmas Party on December 7 at the Wishbone Restaurant in Kansas City. The Allied Trades provided a social hour between 6 and 7 p.m. During the evening door prizes were drawn and awarded. Bingo was played for gifts furnished by participating companies. Fifty-eight members, with their wives and guests, enjoyed the evening. Among those in attendance was John A. Johnson, National President and member of the Section.

The Christmas party committee: Joe Dotson, chairman; W. R. Green, L. L. Warren, Ed Chapman, and W. W. Cochren.

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Southern California Section met on December 6 at Rodger Young Auditorium, Los Angeles. William H. Butz of Beckman Instrument Co. discussed the various instrumental methods for the analysis of minute food additives. His discussion included applications and equipment for testing by infrared spectroscopy, gas chromatography, electrochemical methods, and colorimetry.

Suitable dates to hold the annual joint meeting with the Northern California Section in Fresno were discussed, and members were inclined to favor either March or May.

At the January meeting (3rd), Gordon Miller of the C&H Sugar Refining Corp. spoke about the part played by sugar in the formulation of cake batter and in cake baking.

• • • •

Niagara Frontier Section's Christmas Party was held on Saturday evening, December 17. Bowling, beginning at 6 p.m., whetted appetites for the roast beef dinner served at 8:00, and beer and numerous gifts were distributed on a complimentary basis to convey the Christmas Spirit.

The January meeting (9th) began with cocktails at the home of Mr. and Mrs. William Davis, Snyder, New York, courtesy of Sterwin Chemicals and the Davises' hospitality. Dinner was served at the University of Buffalo's Norton Hall Dining Room. Nucleus of the evening was the talk by National President John A. Johnson, on "Our present knowledge concerning bread flavor."

• • • •

Cincinnati Section's program for its two-day winter meeting at Cincinnati, January 20 and 21, features for Friday afternoon a tour of Proctor & Gamble's Winton Hills Laboratories; dinner later at Mariemont Inn, National President John A. Johnson giving news of Association affairs; and for 8 to 10 p.m., a tour of Striet-mann Biscuit Co. On Saturday morning, Wilbur Hanson, Chelsea Milling Co., discusses the "Relationship between crude fiber and ash of Michigan white wheat bran," and Dr. Johnson reports on "Browning of baked products"; further talks are by J. T. Wilson, Soft Wheat Quality Laboratory, on "Particle Size measurement and distribution of wheat and other starches"; and by John Holme, P&G's Miami Valley Research Center, on "Flour pentosans." After a business session, Perle Whitehead, Deputy Regional Executive, Boy Scouts of America, is luncheon speaker.

New members: Jay Grove, Alabama Flour Mills, Decatur, Ala.; Byron Hummell, Dover Milling Co., Dover, Ohio; Carl Humphrey, Birmingham, Mich.; and O'Dean Kurtz, Food and Drug Administration, Detroit.

• • • •

Midwest Section's January meeting (10th) was in part a symposium on "What's new in products from corn," beginning at 4 p.m. and continuing after dinner. T. J. Schoch, Corn Products Co., was chairman for the discussion on four aspects of the subject: "New developments in production" by Charles L. Ford, American Maize-Products; "Composition and nutritive properties," J. S. Wall, NURDD, Peoria; "Trends in processing: wet-milling," S. A. Watson, Corn Products Co., and "dry-milling," J. R. Wichser, Quaker Oats Co.; "Utilization of products," R. L. Slotter, Illinois Cereal Mills, and Ben Grogg, Quaker Oats Co. Two other papers concluded the program: "Starch and related products in industry" by R. L. Ueberbacher, American Maize-Products; "Starch, sugar, and syrup in foods" by T. J. Otterbacher, Corn Products Co.

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New York Section met on January 10 for the usual dinner and program at The Brass Rail. National President John A. Johnson spoke on "Browning of baked products," and brought members up to date on Association affairs.

The violent snowstorm in the New York area forced cancellation of the scheduled meeting of December 13, when Truman L. Koehler, chief of statistical division, American Cyanamid Co., was to be speaker. Notice of cancellation was short, but members who had sent reservations were reached. Any inconvenience to other members and guests who may have planned to attend is regretted.

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Pioneer Section held a two-day meeting December 9 and 10 at the Lassen Hotel, Wichita, Kansas; an informal gathering of members and wives on Friday, business and program on Saturday.

The resignation of secretary-treasurer Bert Morgensen was announced; Wayne V. Parker, a past Section officer, was appointed to the office for the remainder of the term.

Topic at the formal meeting was "New breadmaking methods employing the principle of vertical mixing." Larry Marnett of the C. J. Patterson Co. discussed the "Ful-Flavor process" in use in a number of their plants; it utilizes a large vertical high-speed mixer, working on the same principle as the laboratory-size mixers but using bowls holding several hundred pounds of dough each. A sequence of bowls are charged with doughmaking ingredients and placed in succession under the mixer. A mechanical dumper empties the bowls of finished dough into the dividing

apparatus.

Mel Huber of the Interstate Bakeries Corp. discussed the "IBC Denver process" and "TendrKurl molding." The process uses a wet mixture during the development of the doughs and eliminates the use of softening agents. The resulting bread has a better flavor, Mr. Huber said, and has found increased public demand.

Luther Lyon, acting head of the Chemistry Department, Wichita University, in an informal discussion entitled "A little history and a little atomic energy," reviewed the history of the development of atomic energy and went on to describe present goals in perfecting processes to utilize products of atomic fission. Dr. Lyon has accepted a position with the University of California and will be working in the field of atomic energy at Los Alamos, New Mexico.

• • • •

Northwest Section members met on December 16. David Jorysch of the Kohnstamm Co. spoke on "The manufacture of pure and synthetic dry flavors and their application." He discussed the intricate blend of compounds that enhance the flavor of foods we eat. Recent work on the methods of spray and fluff-drying of flavors by the Eastern and Western Regional Research Laboratories was described.

A joint meeting with the Canadian Prairie Section has been proposed, to be held at Fargo, N.D.

Next meeting will be on January 24; Lawrence Zeleny, Grain Division, Agricultural Marketing Service, USDA, will speak.

the President's Corner

news of the association

We have experienced a great shock in the death of one of our foremost cereal chemists, Dr. William F. Geddes. His contributions to our profession were many. He was a researcher, a writer, an administrator, a teacher, a lecturer, and a friend.

Dr. Geddes was best known for his ability to analyze complex biochemical problems and to design experiments to show and to demonstrate the true facts of natural phenomena. How well we remember his distinct ability to simplify complex phenomena in his writings and oral presentations. His knowledge will last for generations to come through his extensive writings in the field of cereal chemistry.

Although Dr. Geddes longed to be in the laboratory, demands on his time as an administrator were the greatest. He seldom turned down an opportunity to serve on committees of national and international importance. Many times these assignments meant personal sacrifice, but he gave unstintingly of his time, effort and energy.

As a teacher, he was popular among students. He commanded respect for his great knowledge, for his ability to organize and present facts very clearly. He had a sympathetic ear for the personal problems of his students, but he had little time for the stupid or non-industrious. Many of his students will fondly recall having spent joyous hours as guests in the Geddes home.

Even though we have lost a staunch supporter of the cereal chemistry profession, Bill's influence will live on. Young men who were fortunate enough to have studied with him will keep alive his hopes and aspirations.

Your Board of Directors in recognition of Dr. Geddes' service to the American Association of Cereal Chemists has seen fit to establish a William F. Geddes Memorial Award. This award will be made annually to an individual who contributes most significantly to the furtherance of the Association.

JOHN A. JOHNSON

NEW AACC MEMBERS

ANDRINA, ELSIE D., *Laboratory Technician,* Kellogg Company, Battle Creek, Michigan

ARRIAGA, ERNESTO TORRES, *Laboratory Technician,* Industrias Unidas de la Laguna, Apartado 94, Gomez Palacio, Dgo. Mexico

BECK, WALTER, *Chief Chemist, Quality Control* (Burry Biscuit Co.), 101 Cambridge Road, Westfield, N.J.

BOEDEKER, BILL, Traders Mill Co., Box 1837, Fort Worth, Texas

BROLITE COMPANY, INC., 2542 Elston Avenue, Chicago 47, Illinois. Attn: W. E. Dawson

BUNGENBERG DE JONG, H. L., *Consultant,* Duyn van Maesdamweg 4, de Bilt, Holland

CARLILE, ALBERT C., (Igleheart Bros.), 5 Red Bank Rd., Ft. Branch, Ind.

CAUL, JOHN H., *Chief Chemist* (International Breweries), 230 Pratt St., Buffalo 5, New York

COX, ROBERT L. (Victor Chemical Works), 471 Shabbona Dr., Park Forest, Ill.

DE LUCA, GUIDO, *Chief Chemist* (Catelli Food Products), 1980 Sherbrooke West, Montreal, P. Q., Canada

EXTRIN FOODS, INC., 70 Barclay St., New York 7, N. Y. Attn: R. S. Sweet.

GOODWIN, ANTON E., *Ass't Chemist* (F. W. Stock & Sons), 30 South Manning St., Hillsdale, Michigan

GRAHAM, LESLIE R., *Chief Chemist,* Lincoln Grain Exchange Laboratory, 505 Garfield, Lincoln, Nebraska

GRAY, JAMES S., *Laboratory Director* (Lance, Inc.), 3311 Reid Rd., Charlotte 9, N. C.

GRIFFIN, JOAN M., Chas. Pfizer & Co., 630 Flushing Ave., Brooklyn, N. Y.

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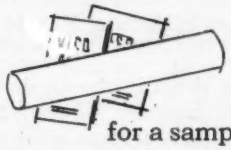

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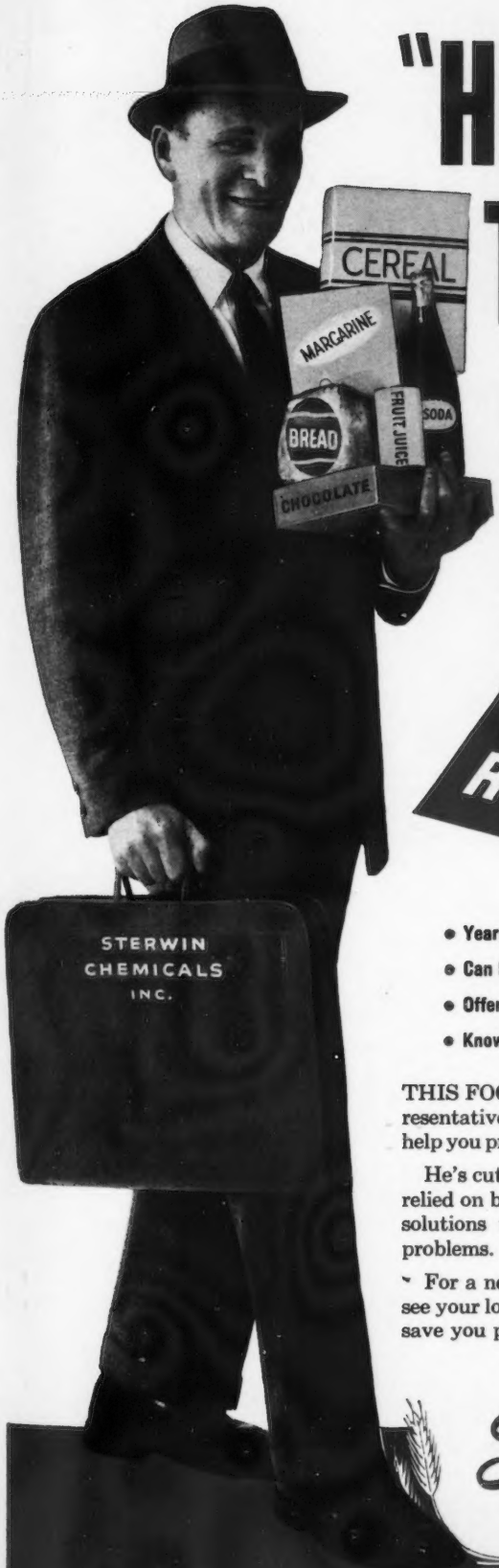

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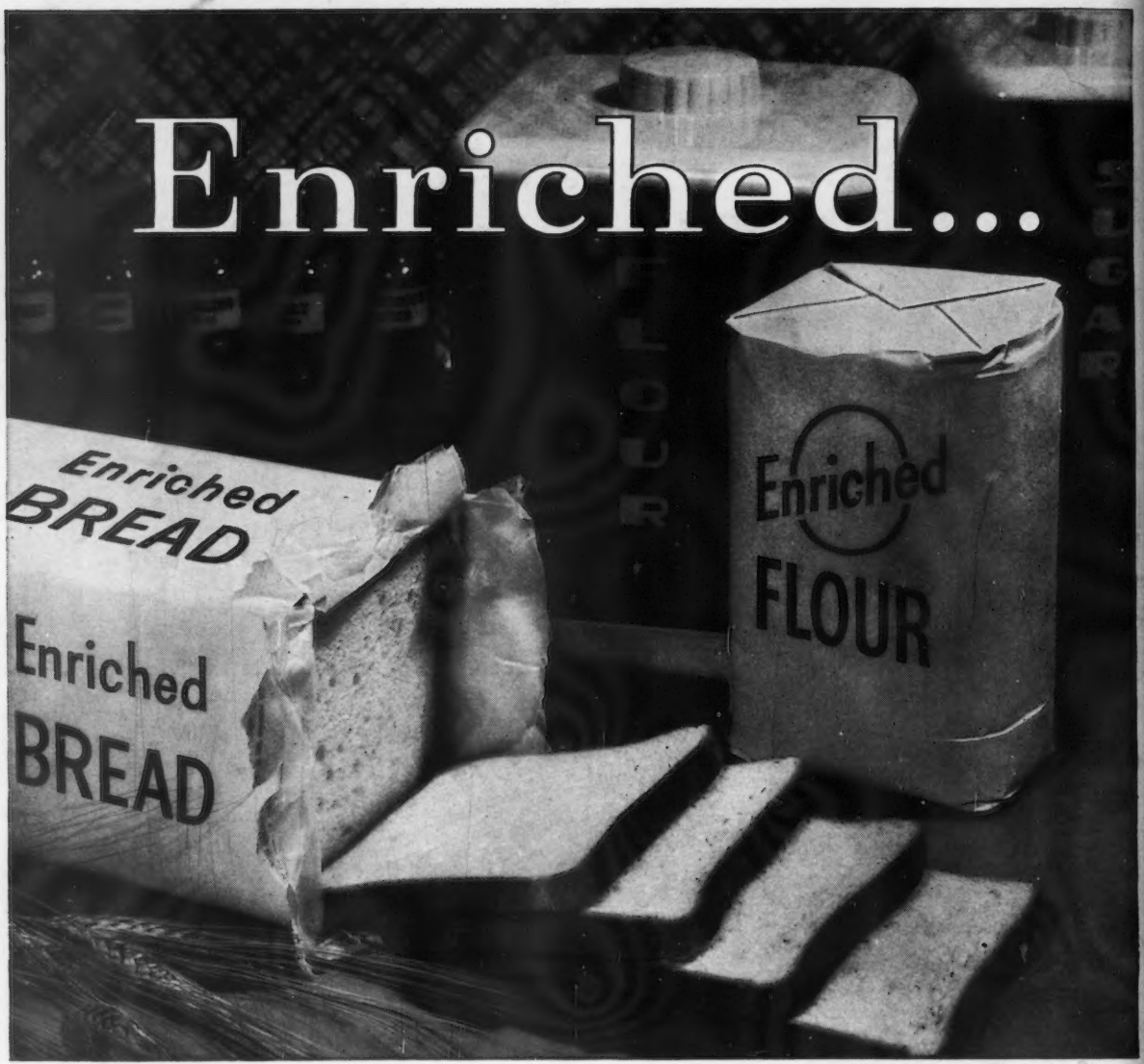

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The U.S. Department of Agriculture* has shown that enriched bread and flour supply more nutritional value for less money than any other major food group. So display the word "Enriched" on your package. This proven way of stressing the nutritional benefits of your product will help you earn your share of the housewife's food dollar and prevent inroads by other foods.

*Report No. 6 in the Household Food Consumption Survey of 1955.

MERCK VITAMIN MIXTURES FOR FLOUR ENRICHMENT

Always specify Merck for vitamin mixtures that are light in color, easy to handle and blend uniformly in every pound of flour.

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